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INDUCEMENTS FOR RETAINING TRAINED SEAMEN IN THE NAVY, AND BEST SYSTEM OF REWARDS FOR LONG AND FAITHFUL SERVICE.

BY COMMANDER N. H. FARQUHAR.

"*Ut Prosim.*"

In days gone by, Poor Jack was pitied by everybody. He was considered an amiable, good-for-nothing fellow; on shore, harmless; a drunkard, and the victim of pimps, runners and prostitutes. "Generous to a fault," "chivalrous," were epithets kindly applied to him. His normal condition on shore was a state of intoxication. A few days sufficed to spend the money saved by years of toil and exposure, and before he realized it he found himself once more enlisted, with no money, and at least three months in debt. During a cruise, if he was given liberty, he was expected to go on a spree or debauch. Admiral Ryder, R. N., in his book "A Seaman's Life on board of a Man-of-war," says: "A few words will describe a sailor's life on board a man-of-war, such as it was in the memory of many living

men. No leave to go on shore from the day the ship was in commission until paid off. No wages until paid off, but occasionally prize money. The ship filled with prostitutes at every port, by permission of the commanding officer. Not many years ago (it was since 1840) the captain of a frigate in a West Indian port (Barbadoes) gave an order to the first lieutenant that every man and boy was to have a black woman on board, and the order was carried out; but that was, at that date, an exceptional case. The majority of the able and ordinary seamen and many petty officers got drunk on every opportunity, viz. when their boats went on shore, or by smuggling liquor on board, or by saving up their daily allowance. Flogging was a weekly, almost daily occurrence. It was almost certain that somebody would be drunk at evening muster, and the punishment was flogging at 11.30 next forenoon. The men could, as a rule, neither read nor write. They were brave as lions, and generous, if utter recklessness with their money when they got it could be called generosity. After a three years' commission, men have received from £60 to £100 of pay alone, irrespective of prize money. As a general rule they lost all their money the first night after the ship was paid off, and the penniless men re-entered for another term of service. Such was a seaman's life: but all this is now changed." This picture of the English man-of-war's-man is a little worse, perhaps, than can be, or ever could have been, truthfully shown of our seamen or of our men-of-war, but the general characteristics as to the sailor are correct. With us the change has been slight, and I am sorry to say that even now the sailors in the United States Navy are among the worst drunkards in the world.

The man-of-war's-man is only an American for the time being, for the dregs of all countries seem to get into our service. The character of the men now obtained is somewhat improved over former years, but there is still much room for improvement. This description of a sailor answered well enough for their time, because the then sailing vessels were directed by the officers: sailors were wanted more for their strength than intelligence. The guns were not instruments of precision, it was mere chance if they hit anything with the shot, except at short range. Would such men do for a modern man-of-war? Most emphatically, no. The improvement most needed in our seamen is not in bravery or fortitude, but in character and general intelligence. The vessels themselves are instruments of precision; while the cannon now carried are delicately sighted and carefully ranged,

heavy in caliber and few in number, which makes it essential that no ammunition should be wasted. Neither could a drunken, stupid man be in any way intrusted with the management of guns, their machinery, or the machinery that propels the vessel; to say nothing of the improved small arms, electrical apparatus and torpedo gear.

Quoting again the words of Admiral Ryder, R. N., "A man-of-war's-man of to-day is not a mere seaman, but a trained warrior. He is an accomplished artillerist, a skilled rifleman, a trained swordsman, a practical electrician, an experienced machinist, and a superior torpedoist, rolled into one."

In order to properly discuss the subject of the essay it will be well to define what is meant by the term Seamen, how they are obtained at present, and who compose that class in our navy.

Fifty years ago the answer could have been more readily given than now. Then, men-of-war consisted entirely of sailing vessels; now, sailing vessels are the exception. The crew of a monitor without any sails are considered seamen in the eye of the law, as much as the crew of a training ship with only sail power, though it is evident that there is a wide difference in their duties. Strange as it may seem to a non-professional, classed among seamen are landsmen. On board of a man-of-war, all enlisted persons, except marines, come under the general head of seamen. In law, the definition of a seaman is "Any person whose employment is necessary, or whose service is useful, in the navigation of a vessel."

Section 1417, U. S. Revised Statutes, provides that the number of persons who may "at one time be enlisted into the navy of the United States, including seamen, ordinary seamen, landsmen, mechanics, firemen and coal-heavers, and including seven hundred and fifty apprentices and boys, hereby authorized to be enlisted annually, shall not exceed eight thousand two hundred and fifty." They can be classified as follows:

1st. *Sailors.*

Those who man the guns, handle the sails, steer the ship, and man the boats, which would include: Petty officers, captains of the different parts of the ship, gunner's mates, quarter gunners, boatswain's mates, coxswains, quartermasters, seamen.

2d. *Mechanics.*

Carpenters, machinists, boilermakers, painters, blacksmiths, coppersmiths, sailmakers.

3d. *Firemen and Coal-heavers.*

4th. *Cooks, Stewards, and attendants.*

5th. *Marines.*

The questions to be discussed in this essay are understood to be limited to: 1st. Sailors; 2d. Mechanics; 3d. Firemen and Coal-heavers.

At present, these men are obtained by enlistment. The recruit being required to be sound physically, between certain ages, and to be able to reef, furl and steer, for the rate of seamen. Firemen and coal-heavers to be competent for these rates. Machinists, blacksmiths, boilermakers and coppersmiths, may be enlisted as such; but all other petty officers are enlisted as seamen or landsmen, except a petty officer holds three continuous honorable discharges as such, in which case he is enlisted as a petty officer.

Seamen enlisted in this way cannot be called trained seamen, in the sense that they owe their training to the United States Navy. A very few of those who thus enlist were apprentices; these are trained seamen, and as I understand the problem, the question refers only to retaining these.

Why so few re-enlist, we must suppose, is because the inducements are not great enough. Let us inquire what these inducements are. Appended will be found the "Shipping Articles." The first, that for an apprentice; the second, for a recruit of age.

The only inducements here held out are the amount of wages the recruit is to receive, and that if he re-enlist under a continuous-service certificate he will receive one dollar a month additional pay for each re-enlistment of three years. It does not tell him that this certificate is a matter of regulation, not law, and its terms may be changed or the whole thing done away with at the convenience of a single person. He is, however, to obey all laws and regulations then in force and that may be established during his term of service. Are these laws and regulations read at once to the recruit? Or does he have a copy given him that he may ponder over them at his leisure before enlistment? I think no one can reply in the affirmative. It is true, on board of men-of-war it is required that certain extracts of laws governing the navy are to be hung up on the berth deck, and the "Articles for the government of the Navy" are read on the quarter-deck at muster, once a month. These, however, relate to penalties rather than to privileges.

But suppose that he is told all. Let us examine what are his inducements.

I.—By Law.

(a) *Pay*, as stated on Shipping Articles.

(b) *Honorable Discharge.* Sec. 1429, U. S. Revised Statutes: "It shall be the duty of every commanding officer of a vessel, on returning from a cruise, and immediately on his arrival in port, to forward to the Secretary of the Navy a list of the names of such of the crew who enlisted for three years, in his opinion, on being discharged, are entitled to an honorable discharge as a testimonial of fidelity and obedience; and he shall grant the same to the persons so designated." Sec. 1573, *ib.*: "If any seaman, ordinary seaman, landsman, fireman, coal-heaver, or boy, being honorably discharged, shall re-enlist for three years, within three months thereafter, he shall, on presenting his honorable discharge, or accounting in a satisfactory manner for its loss, be entitled to pay, during the said three months, equal to that to which he would have been entitled if he had been employed in actual service."

(c) *Pension, for wounds or disability in line of duty.* Sec. 4693, Rev. Stat.: "The persons entitled as beneficiaries under the preceding section (4692) are as follows: *First.* Any officer of the army, including regulars, volunteers, and militia, or any officer in the navy or marine corps, or *any enlisted man*, however employed, in the military or naval service of the United States, or in its marine corps, whether regularly mustered or not, disabled by reason of any wound or injury received, or disease contracted, while in the service of the United States and in the line of duty." Sec. 4695, *ib.*: "The pension for total disability shall be as follows, namely: . . . . and for all other persons whose rank or office is not mentioned in this section, eight dollars per month." . . . See also Secs. 4756 and 4757, *ib.*

(d) *Pension to Widow and Minor Children.* Sec. 4702, *ib.*: "If any person embraced within the provisions of sections 4692 and 4693 has died since the 4th day of March, 1861, or hereafter dies, by reason of any wound, injury, or disease, which under the conditions and limitation of such sections would have entitled him to an invalid pension had he been disabled, his widow, or if there be no widow, or in case of her death without payment to her of any part of the pension hereinafter mentioned, his child or children, under sixteen years of age, shall be entitled to receive the same pension as the husband or father would have been entitled to had he been totally disabled, to commence from the death of the husband or father, to continue to the widow during widowhood, and to his child or children,

until they severally attain the age of sixteen years, and no longer; and if the widow remarry, the child or children shall be entitled from the date of remarriage."

(e) *May be Warrant Officers.* Sec. 1417, Rev. Stat.: "In the appointment of warrant officers in the naval service of the United States, preference shall be given to men who have been honorably discharged upon the expiration of an enlistment as an apprentice or boy, to serve during minority, and re-enlisted within three months after such discharge, to serve during a term of three or more years." See also Sec. 1407, *ib.*

(f) *Buried in National Cemeteries.*

II.—By Regulations of Secretary of the Navy, which can be changed or rescinded at the Secretary's will.

(a) *Continuous-Service Certificates.* Pars. 18, 19 and 20, page 100, Navy Regulations: "All men who enlist for three years, except officers' cooks, stewards and servants, will receive, upon the expiration of their enlistments, if they shall so elect, continuous-service certificates in lieu of the ordinary or honorable discharges. All persons holding continuous-service certificates will be entitled to receive for each continuous re-enlistment for three years, within three months from the date of their discharge, one dollar per month in addition to the pay prescribed for their several ratings; but a person failing to re-enlist within three months from the date of his discharge will cease to derive any advantage from his previous continuous enlistments." "The continuous-service certificates will embrace all the advantages of the honorable discharge in cases where persons are recommended for the same, and must always show, in the column for the purpose, whether or not the person is entitled to an honorable discharge."

(b) *Good-Conduct Badges.* Par. 22, page 101, U. S. Navy Reg.: "Any enlisted man holding a continuous-service certificate, who is distinguished for obedience and sobriety, and is proficient in seamanship or gunnery, shall receive upon the expiration of his enlistment a good-conduct badge; after he has received three such badges, under three consecutive re-enlistments, within three months from the date of his discharge, he shall, if qualified, be enlisted as a petty officer and hold a petty officer's rating during subsequent continuous re-enlistments; and shall not be reduced to a lower rating except by sentence of a court-martial."

(c) *Rewards.* Section 1, Par. 22, U. S. Navy Reg: "The following directions will be observed by all Commanding Officers of vessels in respect to good-conduct classes, badges, and discharges; to granting liberty on shore to ships' companies, and to the allowance of liberty-money."

I. When a vessel is fitted for sea, and has her crew on board, her Commanding Officer will at once commence to designate her crew, in the order of good conduct, in four classes, viz., 1st, 2d, 3d, and 4th.

II. This classification of the crew should be governed at its commencement by the possession on the part of the men of honorable discharges, medals of honor, continuous-service certificates, good-conduct badges, good-conduct discharges, and any other reliable information that can be obtained by reference to the Bureau of Equipment and Recruiting, or from other sources, as to the previous character of the men.

III. As the cruise progresses, such changes should be made in the classes as may be warranted by the conduct of the men, either for the better or for the worse; the general character of the men is to have its due weight, and proper consideration is to be shown to such men as have been noted for acts of gallantry during war or previous service, or during the cruise.

IV. The surest way to make men contented on shipboard, and attached to the service, is to make them feel that our ships of war are their homes, and to make it apparent to them that their interests will be well cared for while they remain in the Navy.

V. The men should also be made aware that their good conduct will entitle them to every practical indulgence.

VI. First-class-conduct men should be allowed such recreations as may be compatible with the demands of duty and with the exigencies of foreign service; and an appropriate distinction should be made between them and the rest of the crew; but this distinction should not be so marked as to excite discontent among the ship's company.

VII. First-class-conduct men should be allowed to go on shore very frequently, in ports where the ship lies convenient to the landing, and where granting liberty is unobjectionable. In such instances a portion of them might be sent on shore daily, after the work and exercises are ended, to return on board by 10 P. M.; but, on any special occasion, to have leave until a later hour.

VIII. In addition to this evening-leave, first-class-conduct men may also have, at the discretion of the Commanding Officer, liberty on shore for twenty-four hours twice a month; and, if out of debt, may also, with the approval of the Commanding Officer, draw from the Pay Officer one-third of their monthly pay, per month, while in port.

IX. Second-class-conduct men may be allowed, at the discretion of the Commanding Officer, liberty on shore for twenty-four hours, once a month; and, if out of debt, may also, with the approval of the Commanding Officer, draw from the Pay Officer one-fourth of their monthly pay, per month, while in port.

X. Third-class-conduct men may be allowed, at the discretion of the Commanding Officer, liberty on shore once in six weeks for twenty-four hours; and, if out of debt, may also, with the approval of the Commanding Officer, draw from the Pay Officer one-fifth of their monthly pay, per month, while in port.

XI. Fourth-class-conduct men may be allowed, at the discretion of the Commanding Officer, liberty on shore for twenty-four hours once in two months; and, if out of debt, may also, with the approval of the Commanding Officer, draw from the Pay Officer one-fifth of their monthly pay, per month, while in port.

XII. In ports the unhealthiness of which may render it unadvisable to send the crew on shore on liberty, such indulgence is not to be granted; and in any case, in a foreign port, the permission of the proper local authorities must first be obtained: otherwise, unless the exigencies of the service shall prevent the granting of liberty to the crew, no one of the ship's company shall be deprived of liberty on shore for more than three months, except he be confined under sentence of court-martial, or under arrest for trial by court-martial.

XVI. The requisite qualifications for first-class-conduct men are as follows; Strict attention to duty, implicit and ready obedience to orders, sobriety, alacrity, courageous conduct, neatness of person and of dress, quiet and respectful demeanor, and general usefulness. This classification will be irrespective of rating.

XVII. Second, third and fourth-class conduct men will be designated from their exhibition, in a less degree, of the qualities enumerated in paragraph XVI, or from their want of them or of any of them.

XVIII. A separate conduct-report will be kept for boys; and when boys are sent on shore on liberty they will be put under the charge of a Petty Officer, or of a Non-commissioned Officer of Marines.

XIX. At the end of a cruise, first-class-conduct men will receive their good-conduct badges before being discharged. The badge will be presented by the Commanding Officer at a special or at a general muster.

XX. Good-conduct badges are to be worn at general musters and on occasions of ceremony.

XXI. Second-class-conduct men may receive a good-conduct discharge if they have been but slightly behind the first-class requirements, and if they have shown a commendable desire to make up for any remissness in conduct; but they are not to receive a good-conduct badge. A good-conduct discharge will be of advantage as a recommendation on re-entering the service or in seeking other employment.

(d) *May become Seaman Gunners.*

NAVY DEPARTMENT, WASHINGTON, *June* 28, 1881.

General Order No. 272.

With the view to the further development of the training system, the following additional regulations will be put in force:

I. Apprentices who have been discharged with a continuous-service certificate as seamen, and who shall re-enlist for five years within three months after

such discharge, may be admitted to the gunnery school for instruction in gunnery.

II. The gunnery school will be established on board such vessel or vessels connected with the training station as may be hereafter designated, and will be termed the Gunnery Ship. To be eligible for admission into this school, the candidate must be over twenty-one years of age and not over twenty-five. His record of conduct must be unexceptionable. He must pass a first-class examination as seaman, be able to read and write fluently, and be familiar with ordinary broadside drill.

The course in gunnery shall last at least six months, and shall include progressive instruction at the different duties and stations of gun-numbers in the various crew formations adopted for general service—the duties of the gun-captain; construction and storage of magazines and shell-rooms; names and uses of the various kinds of projectiles, fuses, primers, etc., and of all the implements used in ordinary service work by the gunner's gang. In addition to proficiency in practical work, the candidate for a certificate must show his ability to station and exercise an uninstructed gun crew, and obtain a certain degree of excellence in target firing.

In small-arms he must know the use and care of such small-arms or machine guns as are supplied to the general service, with the principles of ordinary formations and manual of small-arms.

The course of instruction will also include broadswords, boxing and fencing, and the use of the diving apparatus (elective), and practical drill in laying out and handling torpedoes.

III. Seamen who have successfully passed through the prescribed course, will be given certificates as *seamen gunners*, and a pay of twenty-four dollars ($24) per month.

IV. Seamen gunners will be eligible to the rates of coxswains, captains of the tops, etc., at the current rates of pay. They will be deprived of their certificates as seamen gunners only by sentence of a general or summary court-martial.

V. Every ship carrying heavy guns will be allowed one (1) seaman gunner to each two (2) broadside guns, and one (1) to each pivot gun, as gun-captain.

VI. Commanders of vessels returning from a cruise, and having seamen apprentices on board, will, immediately upon their arrival in a port of the United States, prepare and forward to the Bureau of Equipment and Recruiting a list of such apprentices as may be eligible for admission into the gunnery school.

VII. The Bureau of Equipment and Recruiting will grant all seamen apprentices returning from a cruise the usual leave of absence, and at the expiration of their leave, those who have been recommended will be ordered to the officer commanding the training station for instruction.

VIII. Seamen apprentices who have returned from a cruise, and who have not attained their majority, will, after the expiration of their leave, be sent to the training school to serve out their unexpired terms of enlistment. When there, those properly qualified will follow a course to prepare them for sub-

sequent admission to the gunnery school. Those who have more than six months to serve will be liable to transfer to cruising vessels.

IX. It is contemplated to have the positions of all gunnery petty officers filled, in time, exclusively by selection from among those who hold seamen gunner's certificates, and to require candidates for warrants as boatswain or gunner to hold certificates as seamen gunners.

WILLIAM H. HUNT,
Secretary of the Navy.

NAVY DEPARTMENT, WASHINGTON, *December* 16, 1881.

General Order No. 281.

General Order No. 272 is modified as follows:

Apprentices who have re-enlisted under continuous-service certificates for *three years* may be admitted to the gunnery ship for instruction, subject to the conditions of paragraph II in the said Order. When they shall have successfully passed the prescribed course they will receive certificates as seamen gunners, and pay at the rate of $26.50 per month.

The pay of seamen gunners who re-enlist for three years will be $33.50 per month in addition to the longevity allowance due to the continuous-service certificate, provided, that the seaman gunner shall pass a satisfactory examination (on board the gunnery ship if practicable), and shall have received, during his service afloat, the favorable report of his commanding officer.

No seaman gunner shall receive the increased pay of $33.50 until he has served, as such, at least two years on board a sea-going vessel.

Seamen gunners may be required to perform the duties of any petty officer, with the pay of that rating, if higher than their own.

Such portions of General Order No. 272 as are not affected by this Order will remain in force.

WILLIAM H. HUNT,
Secretary of the Navy.

To have persons remain in any employment it must be made to their interest to do so. It is idle to suppose that a mechanic or laborer will not seek the highest wages, though he leaves an employer with whom he has worked for years. So in the navy, while in war times, as a matter of sentiment, men may serve their country for nothing, in times of peace no such sentiment exists, and only those remain in the navy who cannot better themselves elsewhere. In our rich country there are few persons who cannot earn a dollar a day on shore, yet there are very few men on board ship who are paid this much. The historic reply of an old man-of-war's-man when being reproached by his commanding officer for drunkenness, "that the cardinal virtues of human nature were not to be expected at $20 per month," contains the very essence of the discussion on

this point. Those on shore have all the freedom from restraint they desire, while those in the navy are always under constraint and supervision. Indeed, when given liberty on shore, they are not only subject to the civil law but to the military law, "All offences committed by persons belonging to the navy on shore shall be punished as if they had been committed at sea." A person who enlists in the navy for a term of years gives up home, friends and associations for that time; he severs for awhile his tenderest ties, and in most cases is separated by thousands of miles from those who are most dear to him. In addition, he subjects himself to the unnatural confinement on board ship. If he is so unfortunate as to be in debt, he is virtually a prisoner for this time. The discomforts of ship life cannot be understood by those who live on shore, or at best have made but a passage at sea in the luxurious steamers of the day.

"There is no title perhaps so monstrously abused in popular language and notions as that of *sailor*. To go on board of a ship and assist in making a passage across the ocean, and then to unload her and come back again, is very far from making a man a sailor. He is more of a travelling stevedore than a sailor. To sign the books of a passenger steamer and make a voyage in her from port to port, where the highest duties are to wash off the filth of emigrant passengers, does not make a sailor either. Going out on the banks of Newfoundland in a schooner to drop anchor and fish for cod, is not making a man a sailor. He is about as far from being a sailor as the cod are from being meat. Oystering and clamming are very useful vocations, but one may pursue them many years with credit and yet never become a sailor—very far from it. A man may track a tow-path of a canal all his life and even then not become a sailor. Even a three or four years' cruise round the world in a whaler does not make a sailor; it makes a very hardy, courageous fellow, but he is far from being a sailor still. Steamboat-men, on tugs, steamboats, or our Sound steamers, are not sailors, though they sometimes assume the title for its honor, and claim a usurped privilege, which is theft. Men may live on the water or near the water, or travel over it in long voyages or on pleasant excursions, and yet be no nearer the mark of a sailor than any other traveller or lounger."*

A workman or mechanic on shore works only during the limited hours of the day; a sailor's day has no end. He stands watch day

* Naval Duties and Discipline. F. A. Roe. Pp. 134, 135.

and night; never by any chance, at sea, has more than eight hours' sleep out of the twenty-four. He is liable to be, and often is, disturbed of this rest to go on deck in stormy weather and work all the night long in rain, snow, sleet and hail, with seas washing over him. When such a night's work is over he has no comfortable bed to go to nor a dry, warm room to rest in. Even Sunday, a day of repose for those on shore, is but little different from other days on board ship. The saying is very true:

> "Six days shalt thou labor and do all thou art able;
> On the seventh, holystone decks and scour the cable."

"Their lives are a perpetual combat with danger in every form; danger from accidents, if they go aloft or if they go below; danger from shipwreck, from storm, from a faulty ship; danger from air, fire, and water; danger from disease; danger from battle; danger from boat service—a service full of peril always; danger from collision; and danger everywhere."*

Training System.

It may be asked why the Training System has not supplied the navy with the required number of trained men? As early as 1840, an attempt was made to enter apprentices and thus get a better class of men for the navy. But want of system, want of encouragement, soon brought it to an untimely end. Again, in 1863, the matter was revived, under a most excellent system of regulations and management; but the inducement held out that a certain number would be appointed cadet midshipmen caused many to enter to compete for this prize, but, when disappointed in this, they either got discharged, through the influence of friends, or deserted, or remained discontented through their term of apprenticeship and never re-enlisted. Besides these difficulties, there was, for some unknown reason, much opposition to the system and boys, on the part of many of the older officers, and in consequence their position was uncomfortable in the service generally.

In 1875, Rear Admiral Shufeldt, then captain, became Chief of the Bureau of Equipment and Recruiting, under whose cognizance this branch of the service came. He, besides being a man of great intelligence and perseverance, is a great philanthropist and humanitarian.

* Naval Duties and Discipline. F. A. Roe.

Under his able administration the apprentice system was revived, and through his energy and perseverance in a few years there were more than 1000 on the books, and a fleet which formed a large part of our navy was constituted for them. The whole condition of the sailor was so much improved that desertions in less than two years fell from 1203 to 669, or about one-half, and punishments became very much less. And, for the first time in the history of the navy, men were classified and given privileges according to their conduct. (See Navy Regulations already quoted.) An attempt was also made to give uniformity in punishments. His successors have continued his work, except in one important particular, namely, laying up the ships in winter, and then having schools to give the apprentices a foundation for an education. This may be the reason so few of these apprentices re-enlist on completion of their apprenticeship. Be this as it may, one is brought to believe that something is still wanting to make the service desirable. Just how many re-enlist I am unable to say, because no statistics are published; but in the ships I have lately served, out of the 300 men only four had been apprentices.

Now there can be no doubt that the navy must be supplied with trained men, and, in a degree, educated men. It also seems evident that these men must be trained and educated from boys. If little attention is paid to the education, and the boys had a reasonable expectation to receive instruction, then the government is at fault.

Section 1417, Revised Statutes, says: "Provided, that in the appointment of Warrant Officers in the naval service of the United States preference shall be given to men who have been honorably discharged upon the expiration of an enlistment as an apprentice or boy to serve during minority, and re-enlisted within three months after such discharge to serve during the term of three or more years." This act passed Congress in 1879. If a single appointment has been made as boatswain, gunner, sailmaker or carpenter in accordance with law, the Navy Register fails to show it. I have known commanding officers to recommend deserving apprentices to be given facilities to prepare for examinations to these grades, and nothing was done. And to-day no commanding officer can give an assurance to any one under his command that they will have an opportunity of competing for such a prize. In other words, there is no standard which an enlisted man may attain which will enable him to be a warranted officer in the navy.

First then, no adequate opportunity is offered to obtain a proper education, and, secondly, if in spite of obstruction such an education is acquired, no assurance is given of the promised reward. A sober, intelligent man does not continue in a service which offers no hope for promotion.

There are an average of 8000 enlisted men in the navy. To keep this number up, there are (taking an average of a number of years as shown by the reports of the Bureau of Equipment and Recruiting) annually enlisted over 5000. Now as the term of enlistment is only three years, this number should not reach more than 3000. The casualties to make such an extraordinary enlistment necessary are made up from those whose terms of service have expired, from desertions, from deaths, and from discharges by request. The losses from death do not average more than five in a thousand.

Very few of these enlistments are of those who have served an apprenticeship. In 1879, of the 5119 who enlisted, only 620 were honorably discharged men. In 1881, of 5270 enlistments, only 434 re-enlisted under honorable discharges. The data furnished by the various reports of the Navy Department are so meagre that it is almost impossible to estimate the waste of the navy. In the British navy the waste is about 13 per cent.; that is, to keep up an average of 18,000 seamen requires an annual addition of 2400 or 2500 persons; while in our navy, to keep up 8000 requires more than twice that number, or nearer 50 per cent. This is enormous, and renders it difficult to have our ships at all efficient in crews.

The English Training System is a great success, their navy being supplied entirely from it, and for two reasons. The first is, that the class who are entered are bettered in their lot by going into the navy, and secondly, a faithful service until 38 years of age is rewarded by a comfortable pension to retire upon. Like with us, all enlistments are voluntary; as their system has been successful, it would be wise to study it, and if possible, improve upon it. Commander F. E. Chadwick's most excellent report on this subject, made in 1879, and published by Congress in 1880, Ex. Doc. 50, gives a most complete and interesting account of this system. The most striking contrast with ours is in the matter of education. I am constrained to think this neglect on our part is the chief reason why our system has had so little success.

I would recommend the following inducements for retaining trained seamen in the navy, and system of rewards for long and faithful service.

INDUCEMENTS.

1. *Opportunity to become warrant officers.*
2. *Opportunity to become seamen gunners.*
3. *To be made permanent petty officers.*
4. *Commutation in reducing enlistment terms of service for good behavior.*
5. *Honorable discharges, continuous-service certificates, medals, and bounty for re-enlistment.*
6. *An outfit on each re-enlistment.*
7. *Government savings bank.*
8. *Uniformity of privileges, indulgences and punishments.*
9. *Pension for disability received in line of duty.*
10. *Pension to widows and minor children.*

REWARDS.

11. *Pension after twenty-one years' service after attaining majority.*
12. *Employment in life-saving service.*
13. *To be enlisted for special service on receiving ships.*
14. *Preference given for employment in navy yards and stations.*

In giving directions for cooking a hare, a certain cookery book says it is necessary first to catch the hare. So in this discussion. I propose first to catch the seaman.

Opportunity to become Warrant Officers.

From the description given of a sailor's life, it is evident that an essential to contentment on board ship is to have few ties on shore. Apprentices should be enlisted between the ages of fourteen and sixteen. They should serve in the training squadron until eighteen, and then sent to cruisers to serve until twenty-one. In order that they may hold their own on board of cruising vessels, they should be sent in detachments of not less than fifty. While in the training fleet they should serve one-half of each year at sea; the other half should be spent at the headquarters of the training service. The time not spent at sea should be devoted to instruction in reading, writing and arithmetic, the foundation of learning; and such drills and practical work as may be required to fit a lad for the service.

There should be a machine and carpenter shops at the station as

well as a rigging and sail loft. Should an apprentice be found capable of being farther advanced in his studies, every aid and encouragement should be given him. Should it be ascertained that an apprentice has an aptitude for a machinist, carpenter, or sailmaker or boatswain, his bent in these directions should be developed by additional opportunities in these shops. When they are sent to sea at eighteen, full particulars should be sent with them of any specialty they may have, and their commanding officer be directed to encourage and aid them.

Competent schoolmasters or junior officers should be sent with every detachment, and those apprentices who wish to continue their studies should have the opportunity.

If possible, boys from our cities whose parents are dead and the children of poor people should only be enlisted. These lads would be so much better off in the navy than they were before that they would be more attached to it than lads from the country or the intractable sons of parents well to do. In two years a lad of very ordinary capacity could be taught to read, write and cipher, so that they would require to know very little to commence their naval career. To supply the waste of the navy it will be necessary to have one thousand enlisted annually for the next ten years, and then a reduction of one hundred per year till the number of enlistments is reduced to five hundred per year.

In enlisting apprentices, not only have lads been taken from the seaports, but from the interior, even from Western country—boys from farms, boys from printing offices, and boys who were intractable at home. Altogether they made a fine lot; they did not lack intelligence, they generally behaved well on board ship, and in fact were in every way desirable as part of a ship's company. But the confinement was irksome to them. When they had served their time (many did not wait that long) they were paid off, with honorable discharges, medals and commendation; but what inducement had they for re-enlistment? Their commanding officer could only say, I will do what I can for you; he could not assure them of anything. He could not say to the boy, You have done so well on board or during your term of service, that I will see that you have an opportunity to compete for a warrant officer or even seaman gunner, because there is absolutely no standard laid down which would entitle them to compete for these honors. The commanding officer can recommend, and that is all, and perhaps never receive any notice of the communication.

I happened to serve on board of a ship, the major part of whose crew, about seventy, were apprentices enlisted when Rear-Admiral Shufeldt was Chief of the Bureau of Equipment and Recruiting. They had served about two years on board of a training ship. They were as fine a body of young men as one could wish to see; well developed, intelligent, and out of debt—bags full of clothes; they went at once to their stations, and that part of the ship's company was organized. They served on board this ship until reaching majority, about three years. They gave great satisfaction. On the expiration of their enlistments a few, I think four, were recommended by their commanding officer to be given facilities to become instructed at one of the navy yards in the duties of sailmaker, gunner and boatswain, that they might have an opportunity to become warrant officers. Nothing was done for them, and I very much doubt if there are any of this lot of seventy in the service to-day. How simple it would be for the Government to appoint annually, after a competitive examination, according to prescribed forms and upon specified subjects, a certain number of warrant officers from those who had served as apprentices, and stop making such appointments from outside of the navy. The law says preference shall be given to these men, and the whole machinery of the examination and appointment is under the control of the Department. It would be better if there was an act of Congress directing the Department to make a certain number of these appointments annually, appointees to be selected according to merit from all entitled to compete.

A board of officers could be assembled to draw up regulations, specifying, first, the requirements of those who will be allowed to compete for these positions; secondly, the character of the examination to be passed; and, thirdly, the facilities to be given to acquire the knowledge.

The law says, that to be entitled to such a warrant, the candidate must re-enlist for three years, within three months from the date of his discharge as an apprentice. My plan would be to first classify the apprentices according to the year in which their terms expire; for instance, the class of 1885 would be composed of those entitled to discharge during that year; then establish a standard which must be attained to entitle one to be a candidate. Then, having selected the candidates, let them be sent to navy yards, torpedo station, gunnery ship and experimental battery for instruction. They could work while being instructed, and thus the Government would have some return.

For boatswain, carpenter and sailmaker, two years would probably be enough to spend at the navy yard. For gunner, this time could be divided between the Washington navy yard, torpedo station and experimental battery. At the expiration of this time let them be examined competitively, those who pass the required examination to be arranged in order of merit, and the vacancies in the warrant officers filled thus with acting appointments. Those who fail to pass, or for whom there are no vacancies, to be returned to the service.

Such a course would introduce a reform in the navy much to be desired.

In this connection I may be permitted to give my views upon the necessity of having warrant officers on board our ships. Warrant officers are the connection between the commissioned officers and the crew; they are leading men. It might happen that among the crew sent to a ship there were none qualified for boatswain's mate, gunner's mate, carpenter's mate or sailmaker's mate; the presence of corresponding warrant officers would be invaluable in fitting out the ship, or in any emergency. It has been said that warrant officers, with all the vices of sailors, wish all the privileges of commissioned officers, and that they are not diligent in the performance of their duties. If commanding officers do their duty this would not be the case, and this state of affairs can easily be rectified.

There are now on the active list 45 boatswains, 39 gunners, 51 carpenters, 32 sailmakers. On the basis of thirty-five ships in commission, with sail as well as steam power, there should be 70 of each grade; one-half at sea at one time. If this number be gradually reached, say by ten appointments a year, the limit above would never be exceeded, and could not be reached in ten years. Then the waste would be sufficient to keep up a demand at this rate.

Firemen and Coal-Heavers.

Such apprentices as evince a desire to become firemen and show a skill in handling machinery, should be given an opportunity, on re-enlisting after attaining their majority, to be taught the duties of firemen. They could first be sent to the shops in our navy yards and taught to fire boilers on shore, the different parts of the boilers and engines, and their connection. After a year's experience they should be sent to steamers for instruction in their duties. The best vessels for this purpose would be those that are constantly under steam, such as dispatch and transport steamers and monitors. They should be well

paid, and receive an additional pay on each re-enlistment, and should be eligible to promotion to machinists, boilermakers and coppersmiths, and be given the preference for such positions. These men are of the most valuable and necessary on board ship, and their life when under steam is a laborious one and trying to the health.

Coal-heavers should be enlisted as now. Their duties are such as require robust men, and do not call for any great degree of intelligence.

Apprentices should not be required to serve as coal-heavers or firemen, except in cases of emergency, because this kind of work for growing lads would be very injurious to their health. The great heat to which they are exposed when on watch, and the great change in temperature to which they are exposed when off duty, are such that only men of very strong constitutions can stand them.

Seamen Gunners.

General orders Nos. 272 and 281 would be quite sufficient if they provided for instruction in torpedoes, such as charging, connecting and exploding them, and a course in practical electricity; and if they were carried out. Although both of these orders were issued in 1881, I feel quite safe in saying there is no gunnery ship in the service to-day, and that these orders have never been carried out. There are several steam sloops of war available for this purpose; one of these, with a tender sufficiently large to mount a couple of guns (like the Standish now in use at the Naval Academy), should be immediately commissioned, and the entire crew, exclusive of firemen, coal-heavers, marines and attendants, should be composed of re-enlisted apprentices, or those who may have a short time to serve and intend to compete for seaman gunners. An addition to the terms of the order should be that all petty officers should be appointed from seaman gunners, when they are available.

Permanent Petty Officers.

NAVY DEPARTMENT, WASHINGTON, *November* 21, 1884.

General Order No. 327.

From and after January 1, 1885, the form of honorable discharge from the naval service, authorized by Section 1427, Revised Statutes of the United States, will be the "Honorable Discharge and Continuous-Service Certificate."

All men (except officers' cooks, stewards and servants enlisted for special service) now serving under enlistments for three years, or who may hereafter enlist for that period, shall receive an "Honorable Discharge and Continuous-

Service Certificate" at the expiration of their terms of enlistment, upon the recommendation of their commanding officers.

Any man holding an "Honorable Discharge and Continuous-Service Certificate," who re-enlists for three years, within three months from the date of his last discharge, shall receive an increase of one dollar per month to the pay prescribed for the rating in which he serves, for each consecutive re-enlistment, in addition to the "honorable discharge money."

Any man holding an "Honorable Discharge and Continuous-Service Certificate," who fails to re-enlist within three months from date of last discharge, will derive no further advantages therefrom.

The Department directs that the records of conduct and professional qualifications on the "Enlistment Records" shall be a verification of the recommendations for "Honorable Discharge and Continuous-Service Certificate," and hereafter only those shall be recommended who obtain, during their terms of enlistment, a general average of four.

In order that commanding officers of vessels upon which men complete their terms of enlistment shall be informed as to the previous merit of said men, the original "Enlistment Record" (Form 12), which accompanies an enlisted man upon his first transfer, will hereafter be carefully preserved and accompany him upon all subsequent transfers, until his term of enlistment has been completed. This form has been amended so as to show the record of conduct as averaged by the commanding officer of the vessel for the period for which the man has served under his command. The final averages will be made by the officer under whom the man is serving at the time his enlistment expires, when about to be discharged. These "Enlistment Records" must be forwarded to the Bureau of Equipment and Recruiting.

In addition to the above requirements, enlisted men must serve at least two years and nine months of their terms of enlistment in order to receive an "Honorable Discharge and Continuous-Service Certificate," except in extraordinary cases, which will be provided for by the Department as they may occur.

When any man holding an "Honorable Discharge and Continuous-Service Certificate" shall fail to receive a recommendation for its renewal upon the expiration of his term of enlistment, the words "not entitled to Honorable Discharge" shall be written on the line below the last entry. Men so discharged will receive no further pecuniary benefit from their "Honorable Discharge and Continuous-Service Certificate," and entries of a re-enlistment or subsequent service must not be noted thereon.

"Good-Conduct Badges" are special distinctions for fidelity, zeal and obedience, and will not be granted for the first term of enlistment under "Continuous Service." At the expiration of subsequent re-enlistments for three years, within three months from date of discharge, men who hold "Honorable Discharges and Continuous-Service Certificates," have obtained a general average of four and five-tenths (4.5) on their "Conduct Records," and are recommended by their commanding officers, will be entitled to and receive said badges. The first badge will be a medal, as hitherto. Subsequent badges to

be clasps, with the name of the vessel from which given engraved thereon, to be worn on ribbon above medal. When any enlisted man shall have received three such badges, under consecutive re-enlistments as above, he shall be enlisted as a petty officer in the rating in which he is best qualified to serve, and shall continue to hold a petty officer's rating during subsequent continuous re-enlistments, and shall not be reduced to a lower rating except by sentence of Court-Martial.

Paragraphs 18 and 20, page 100, and paragraph 22, page 101, U. S. Navy Regulations, are hereby annulled.

WILLIAM E. CHANDLER,
Secretary of the Navy.

The above General Order is very good so far as it goes. In my opinion, it should go further. It should prescribe the requirements of every grade of petty officer, and none should be appointed that could not attain the standard. In addition, any petty officer who was discharged as such, at the expiration of any enlistment, should have a preference for the same billet on a re-enlistment. Permanent petty officers should hold such appointments from the Secretary of the Navy or Chief of the Bureau of Equipment and Recruiting, in the same manner that non-commissioned officers of the Marine Corps hold their appointments from the Colonel Commandant.

I know of no particular rule or regulation setting forth the requirements of petty officers; in consequence, a petty officer in one ship may have quite a different standard to reach than the same rate in another ship. This should be rectified and a uniform standard adopted for each rate.

Commutation in Reducing Enlistment by Good Behavior.

Seamen are enlisted for three years. I would propose, that for every year of good behavior one month be taken off; so that a three years' enlistment might be reduced three months, and in twenty-one years' enlistment it would only make that many months. This gratuity, in my opinion, would be a great inducement to good men to remain in the service, besides being a substantial reward for good behavior. The comfort of every one on board ship is so much enhanced by the good conduct of the crew that every reasonable inducement should be given to attain this desired end. While I do not wish for a moment to name penitentiaries and men-of-war in the same category, still there is one similar element, that of restraint. Now, in all prisons this commutation is in vogue, with most bene-

ficial results. It is the hope, the ray of light, to the forlorn convict, and makes him obedient when punishment had failed to do so. The loss to the Government would be nothing compared with the gain of having good men in the service.

Honorable Discharges, Continuous-Service Certificates, Medals, and Bounty for Re-enlistment.

Under this head, honorable discharges and bounty for re-enlistment are provided for by law, as heretofore quoted. It would be much better if the law covered all. An honorable discharge must be given to those who deserve it as a testimonial of fidelity and obedience, upon the recommendation of the commanding officer.

The question of what is meant by fidelity and obedience is very puzzling. One commanding officer may, and does, say, for example, that drunkenness on shore should not interfere with this discharge, while another has the contrary opinion; so that a drunkard from one ship will get such a discharge and the same man from another would not. Again, the law is silent as to his professional qualifications, so that as long as a man behaves himself, even though he be dull and stupid, he is entitled to this reward.

The continuous-service certificate which, unfortunately, is only regulation, and liable to be discontinued, or altered for better or worse, is faulty, in that marks therein given are given by the commanding officer when a transfer or discharge is made, and need not be from any record that may have been kept. The officer of division should be required to mark the men of his division at least monthly. These marks, if approved, should be published to the crew, and the average of them should be given in case of transfer or discharge. In conduct, the mark should be given by the executive officer. This would warn a man who was behindhand to improve, and would show those who did well that their efforts were appreciated. Besides, it would give all concerned an opportunity to appeal and have any errors corrected. Let the crew see they are being dealt with fairly and openly, and I feel sure it will be a great inducement for them to remain in the service.

Outfit on each Re-enlistment.

Soldiers and marines receive not only an outfit on enlisting, but a yearly allowance of clothing. Why should seamen not have the

same? Surely they are as much entitled to it as the marine who serves with them. The seaman should be given it as an act of justice to him. It has been estimated that this outfit will cost about fifty dollars ($50). At present, a man who enlists in the navy is at once this much in debt to the Government, and by regulation, a seaman in debt cannot have leave or liberty. Fifty dollars represents about three months' pay, so for that time the man is a prisoner, which is certainly not right or fair. If it is not deemed advisable to give this outright, it might be charged against the recruit at the rate of two ($2) dollars per month till all is paid. If the man deserted, the Government would lose its balance. I believe that many of the desertions now are the result of this confinement on board while getting out of debt. It certainly gives much dissatisfaction. I firmly believe that the granting of this outfit will be a great inducement to seamen to remain in the service.

Government Savings Bank.

In our army the soldiers are given four per cent. for their savings. An Act of Congress was passed for this purpose in 1872. Section 1305, Revised Statutes, is as follows: "Any enlisted man of the army may deposit his savings, in sums not less than five dollars, with any Army Paymaster, who shall furnish him a deposit book, in which shall be entered the name of the paymaster and of the soldier, and the amount, date and place of such deposit. The money so deposited shall be accounted for in the same manner as other public funds, and shall pass to the credit of the appropriation for the pay of the army, and shall not be subject to forfeiture by sentence of court-martial, but shall be forfeited for desertion, and shall not be permitted to be paid until final payment on discharge, or to the heirs or representative of a deceased soldier, and that such deposit be exempt from liability for such soldier's debts. Provided, that the Government shall be liable for the amount deposited to the person so depositing the same."

Section 1306. "For any sum not less than fifty dollars so deposited for the period of six months, or longer, the soldier on his final discharge shall be paid interest at the rate of four per centum per annum."

Section 1307. "The system of deposits herein established shall be carried into execution under such regulations as may be established by the Secretary of War."

"The Secretary of War commends this system of banking in the highest terms, and states that it has been the means in a marked

degree of decreasing desertion, and thereby increasing the tone and morale of the army. The system is also in operation in the British Navy with like gratifying results."

A seaman has no opportunity to invest his savings during the period of his enlistment. Frequently on a foreign station, he could not invest if he would. The consequence is, as a rule, he squanders his hard-earned wages in riotous living, when he gets an opportunity on shore. It would be a simple matter at the end of every quarter for a seaman to deposit with the paymaster his savings. The paymaster could enter the amount in a column for the purpose in the quarterly returns, and add the interest every quarter. At the expiration of the term of enlistment the man could be paid principal and interest, or if he desired to re-enlist, his savings might be transferred to his new account on re-entering. By so doing, a man after twenty-one years service might have enough laid by to make his old age reputable and comfortable. A great fault with sailors is their reckless extravagance. Such a Savings Bank system would tend in a great degree to cure this evil. A matter so simple, and which has elsewhere been tried with such good results, certainly should have a trial in our navy.

Uniformity of Privileges and Punishments.

I have already given the system of rewards to, privileges of, and grading of a ship's company as now authorized in the navy. There can be no question but that this has been an immense benefit to the service and reflects great credit upon its originators. Unfortunately, it is simply regulation, not law, and may be changed at any time for the worse, as well as for the better, and even as regulation it is not fully carried out.

The defects of this system are, that while a high standard is required for the first grade, so high as to be barely attainable, the arrangement of the other grades or the qualifications for them are left to the commanding officer. This latter defect is a very serious one, and confirms the old yarn of "different ships, different rules." Instead of a sailor being justified by saying that in the last ship such rules were observed and he expected the same to hold in his present ship, he finds to the contrary; and that whatever he may have been taught as proper in the last ship does not of necessity mean the same now. Much discontent arises from this. A board of competent officers should be appointed to devise a uniform system of rewards and indulgences, and a uniform system of qualifications for the various

conduct grades. These, after the approval of the Secretary of the Navy, should become law.

The Navy Regulations of 1876 described the punishments that a commanding officer might inflict, and suggested a list of offences and punishments therefor, as follows:

PUNISHMENTS.

For the purpose of promoting good order and discipline in the Navy, and to secure uniformity in awarding punishments, the following schedule of offences, with proportionate and appropriate punishments, will be adopted in all vessels of the Navy as applicable for infliction by Commanding Officers of vessels, without resort to summary or to general courts-martial:

A. Solitary confinement, 5 days or less; no irons; bread and water.
B. Solitary confinement, 3 days or less; no irons; bread and water.
C. Solitary confinement, 7 days or less; no irons; full rations.
D. Solitary confinement, 5 days or less; no irons; full rations.
E. Solitary confinement, 3 days or less; no irons; full rations.
F. Confinement, 10 days or less; double irons; full rations.
G. Confinement, 5 days or less; double irons; full rations.
H. Confinement, 3 days or less; double irons; full rations.
I. Confinement, 10 days or less; single irons or without irons; full rations.
J. Confinement, 5 days or less; single irons or without irons; full rations.
K. Confinement, 3 days or less; single irons or without irons; full rations.
L. Confinement, overnight; single irons or without irons; full rations.
M. Reduction of any rating established by himself.
N. Deprivation of liberty on shore.
O. Extra duties.

List of offences suggestive of such as may be punished by order of Commanding Officers of vessels:

No. 1. Absence without leave..... N
No. 2. Leaving boat or working-party..... N
No. 3. Making false charges against any of the crew, if made by Petty Officer or other person rated by Commander..... M
No. 4. If by Petty Officer, or other person not rated by Commander..... O
No. 5. Lying..... O
No. 6. Answering for another man at watch-muster, at quarters, or in a boat..... O
No. 7. Being habitually dirty or slovenly. (As a reformatory measure in such cases, besides the punishment, frequent inspections of the person and clothing by Officer of Division or Deck, or by Master-at-Arms or Ship's Corporal, should be made until the habit is reformed. The Marine Officer or Non-commissioned Officer of Marines shall make these inspections with the marines)..... O

No. 8. Not being in proper uniform (frequent inspections also)....	O
No. 9. Neglecting to carry out orders.....	O
No. 10. Disobedience of orders.....	A to L
No. 11. Drunk at sea or on duty.....	M or O
No. 12. Returning from leave drunk.....	none
No. 13. Occasionally drunk.....	M or O
Confinement until sober, as a precautionary measure, in these cases.	
No. 14. Smuggling liquor.....	A
No. 15. Trafficking in liquor.....	A
No. 16. Neglect of ordinary duty, or negligently performing it.....	M or O
No. 17. Not answering muster at watch or quarters.....	M or O
No. 18. Malingering	M or O
No. 19. Inattention to duty (frequent inspections also).....	M or O
No. 20. Gambling	A, M, or O
No. 21. Misbehavior at Divine service.....	A, M, or O
No. 22. Making noise on deck, aloft, or at quarters.....	A to L
No. 23. Spitting on deck, either below or from aloft.....	O
No. 24. Sleeping in tops or in boats, whether top or boat keeper or not.....	O
No. 25. Getting in or out of ports.....	O
No. 26. Throwing things overboard from improper places.....	O
No. 27. Not making or not having clothes or hats made in time.....	O
No. 28. Carelessness about clothes-bag, or going to it without permission.....	O
	O
No. 29. Leaving clothes about.....	O
No. 30. Hanging hammocks or clothes in improper places.....	O
No. 31. Washing hammocks or clothes in improper places.....	O
No. 32. Washing hammocks or clothes badly or at improper times.	O
No. 33. Lashing hammocks badly (frequent inspections also).....	O
No. 34. Untidiness as to hammock or bag (frequent inspections also).....	O
No. 35. Cursing others, or using obscene language.....	A or B
No. 36. Striking inferiors or equals.....	A or B
No. 37. Fighting	A or B
No. 38. Quarreling with words or using provoking language.....	F to L
No. 39. Smoking out of hours or in improper places.....	F to L
No. 40. Having lights after hours.....	F to L
No. 41. Negligently letting fall or lowering anything from aloft.....	O
No. 42. Using knife or marline-spike aloft without good lanyard...	O
No. 43. Carelessness with respect to arms (frequent inspection)....	O
No. 44. Not keeping arms clean (frequent inspection).....	O

In all cases in which extra duty is imposed as a punishment it should be as nearly as possible of the kind of duty that has been neglected, if awarded for neglect of duty; and, if awarded for other offences, it shall be of such nature as will most tend to correct them and prevent their repetition.

Aggravated cases in the preceding list of offences can, of course, be referred to summary courts-martial, or to general courts-martial, at the discretion of Commanders of vessels, to whom alone the law confides the power to inflict punishment, or to cause it to be inflicted, on board vessels of the Navy, by the exercise of their own authority.

If these had the authority of law, or were mandatory instead of suggestive, they might have been beneficial to the service, but in their present yielding form they are virtually void. The navy is not to be governed by suggestions, but by commands. I do not mean to be understood as approving this code, on the contrary I think it very faulty, but had it the force of law one could be reconciled to it.

In my opinion the punishments, in most cases, are disproportioned to the offences. For example, absence without leave, and leaving a boat or working party, offences nearly akin to desertion, are punished only by deprivation of leave on shore, and it may happen there is no opportunity to give leave. So also making false charges, lying, being dirty and slovenly, being drunk, spitting on decks, are punished alike by extra duties. While smoking out of hours, or in improper places, by confinement in irons, single or double, not exceeding ten days.

With all due respect, I must say that nothing could be more absurd or more unjust. Can it be possible that it is a more serious matter to smoke out of hours than to lie, to get drunk and therefore be unfit for duty? Surely a system of morals founded upon such ideas would ruin any community, and why not a man-of-war? Again, making a noise on deck, aloft, or at quarters is to be punished by confinement, solitary, on bread and water for five days or less, or confinement with or without irons for ten days or less. If such regulations were read over to thinking men they would never enlist unless driven to do so by desperate circumstances. Would any man enlist were he told that if he made a noise on board ship he would be imprisoned on bread and water, or in irons? I admit that noise is detrimental to a successful drill or exercise, but I cannot say or believe that it is criminal, or that it is more immoral than to deceive, to lie, or to get drunk, or so great a breach of discipline.

I do not believe this code is strictly carried out on any vessel of war now in commission. It should be revised by a Board of Officers, and, if then approved, become law. There should be an absolute uniformity in punishments for offences, as the privileges and rewards are so dependent upon them. There are many officers in the navy

who look upon drunkenness as natural to a sailor, and therefore should not be severely dealt with. Indeed, I have heard some say that they never knew a good seaman who was not a drunkard. There are others who look upon this as one of the worst crimes, and think no punishment too severe. And so with many other misdemeanors. Yet these commanders are both sincere in their convictions. With such a state of affairs is it to be wondered that so few good men, trained seamen, re-enlist? Manifestly, then, one great inducement would be a uniform system of rewards and punishments. It would be better to have a law enacted; but in the absence of a law, a peremptory regulation established by the Secretary of the Navy could be drawn up to remedy these defects.

Pensions for Disability, Occurring in Line of Duty.

If the law were amended so that these pensions should be graded according to the rate held by the seaman at the time his disability occurred—the present law places the best man on the same footing with the poorest—it would be a desirable improvement.

Pensions to Widows.

The sections of the Revised Statutes already quoted place the highest pension to a widow at eight ($8) dollars. No amount of good service of the husband can make it more. No matter if he is a first-class petty officer or an ordinary seaman, his widow's pension is the same. This should, in justice, be changed, so that the widows may receive pensions according to the rate held by, and the merits of, their deceased husbands. It seems to me that a board of officers might devise an equitable scheme which, no doubt, would receive the approval of Congress and the President. Let a man see that merit will be considered and he will not only be more contented, but will strive to be meritorious.

REWARDS FOR LONG AND FAITHFUL SERVICE.

Pensions for twenty-one years Service after Majority.

Every seaman who serves twenty-one years continuously, as such, after reaching the age of twenty-one, should receive a pension according to his merits.

(1) First-class Petty Officers entitled to be enlisted as such, and

who have complete good-conduct badges and honorable discharges, one ($1.00) dollar per day.

(2) First-class Petty Officers, entitled to be enlisted as such and who have not less than half the good-conduct badges, and all the honorable discharges, and all other Petty Officers who are entitled to be enlisted as such, and who hold complete good-conduct badges and honorable discharges, seventy-five (75c.) cents per day.

(3) Other Petty Officers, who are honorably discharged on the completion of twenty-one years continuous service, after majority, and seamen who are honorably discharged after this service, fifty (50c.) cents a day.

The age of an apprentice, sixteen, which is as old as one can enter, would, with his service as apprentice, five years, and twenty-one years after, make twenty-six years of continuous service to the United States. These are the best years of his life. During this quarter of a century of service he will have had no opportunities to make friends on shore, or to seize any opportunity to make a living outside of the navy. He will be forty-two years of age, and will be much broken by his service afloat. It will be some time before he can find something to do to help to support him. He will naturally want to marry and have a home; unless he has this help from the Government he will not be able to do so. I do not think it at all unreasonable after a quarter of a century's service at sea, away from home, on a small pay, that the Government should be asked to pay these moderate pensions. Besides, the standard is high, that it seems very little to give for so much worth, so much value received.

Can it be doubted that this will be a greater inducement than anything else? When a man realizes that he can be provided for life, will he not strive to do well, and will not more remain in the service than do now? At present the seaman has little opportunity to better himself in the navy, no way of providing for his old age except to go to an asylum, so he very naturally leaves and tries something else. He tries the merchant service, where he can get to be an officer. He tries steamboating or yachting, which pay better, in which he has a more comfortable time, and which give prospects of advancement. Or he tries a shore life. Men of spirit, intelligence and ambition are what we want in the navy; they are a necessity. The honor of the flag is entrusted to them. But such men are not to be had without paying for them. England gives similar pensions, but at an earlier age, at the age of thirty-eight (38).

The scheme works well there, and I believe this proposed, though not so liberal as theirs, will give good results in our navy. The minor details would have to be considered by a board, but the essential points would be as I have given under the headings (1), (2), (3).

The cost of this plan would not be great. Suppose that an average of one hundred (100) men receive this benefit annually, at an average of seventy-five (75) cents per day; in one year this would amount to about $27,000; in twenty-one years, at this rate, to about $500,000; but the tables of life insurance companies their death rates would show that of 100 men who reach forty-two years of age, not more than one-half would reach sixty-two (62), or be benefited twenty-one years. So to commence, the sum required would be small, and at the end of thirty years from now about $300,000 would be required, which would probably be the maximum.

I venture to say, that if a million dollars of the prize fund were set aside for this, and the interest, when not required, be allowed to accumulate, and be again put on interest, it would suffice to meet the expense. No one could be benefited for years to come, because the present training system has not been in force twenty years, and very few apprentices have re-enlisted under continuous service certificates.

Employment in Life-Saving Service after Discharge from the Navy. Preference for Employment on Board of Receiving Ships, at Navy Yards and Stations.

The right to have such employment can hardly be disputed. That the men would be well suited and qualified for the duties is unquestionable also. If, then, when the trained seamen received their discharges, would register their names to be so employed, and be notified when vacancies occur, I think good men would be secured with very little trouble. And a sailor would see another inducement to remain in the service the required time and perform his duties well.

It is very desirable that the cooking of the ration for the men on board ship should be improved, and many consider that with a little better dietary men would be induced to remain. I think the ship's cooks should be trained for their duties. This has been frequently recommended, and it is difficult to see why nothing has been done. It could readily be managed on board the receiving ships. The navy

ration is the best in the world; let it be well prepared and there will be no cause for complaint.

I have heard men say that they were always glad to get away from the receiving ships because they were uncomfortable and not well treated. According to their representations, they seem to have been regarded, while on receiving ships, as purely objects of prey. If these complaints are true, then it would be an inducement for men to remain in the service to have changes and reforms in the manner of conducting the affairs of these vessels.

The question how to employ men at this stage of their enlistment is a difficult one, for several reasons:

(1.) The ships are usually moored head and stern, and in ports where it would be impossible to fire shots from their guns; and their guns are antiquated, so that to drill the men at the guns is of no practical use.

(2.) The sails are unbent, and as a rule but few spars aloft, so no exercise of the sails or spars is practicable.

(3.) To drill with small arms, howitzers or swords is generally not practicable on board, and as (I believe) only one receiving ship is moored alongside a wharf, it is not convenient to send them on shore for this purpose.

(4.) Even were it possible to do all these things, there are generally so few officers attached to the ships that it would not be practicable. I would remedy this by having enough officers on duty. Then all receiving ships should be moored alongside the navy yards, and a suitable drill and play ground be provided near them. Under the present regime recruits cannot be given liberty. If they had grounds where they could play ball, pitch quoits, and other games, they would be more contented. Besides, there should be reading rooms and what would correspond to a canteen in the army. A small monthly subscription from the seamen would pay for the papers and periodicals, and the canteen no doubt would be self-supporting. If the canteen were abused, punish the offenders and the abuses would soon correct themselves. Make the receiving ships desirable homes for the seamen, and they will not hesitate to re-enlist because of the fear of being uncomfortable and uncared for while awaiting transfer to a sea-going vessel. The customs, privileges, duties and punishments should be alike on all these ships.

The introduction of steam, the improvements in ordnance, the use of torpedoes, and the changes from wood to iron and steel for construction, have necessitated great changes in the requirements and character of the seamen. It is evident that laws, regulations and customs governing an illiterate and generally depraved set of men must be changed when trained seamen of intelligence and education are to be dealt with. A seaman who cannot read and write is of little use now in the service.

I have endeavored to show what the character of the naval sailor was. I have contrasted this with what is required of the seaman of the present day. I have shown some of the evils of the laws and regulations now in force, and have tried to show how they could be improved for the benefit of the seamen. I have named many inducements that might be tried to retain trained seamen in the Navy, as well as rewards to be given them for long and faithful service. All of these are reasonable, only a few require legislation. I feel sure Congress will be glad to pass these acts to do justice to their country's defenders. A Board of Officers should be ordered to devise new regulations and laws suitable to the times. We must educate our men. Our ships have changed, so must the character of our crews. Let it be made to the interest of trained seamen to remain in the Navy, by proper treatment while they remain, and by holding out such rewards as I have indicated for long and faithful service, and the time will soon come when the American man-of-war man will be the pride of his countrymen and the admiration of the world.

SHIPPING ARTICLES *for the enlistment of Boys to serve in the Nav*

We, the subscribers in the subjoined column headed "*Signatures of Recruits*," do, and Navy, in manner and form following, that is to say:

In the first place, we do hereby agree, for the considerations hereinafter mentioned, to en to repair on board such vessel of the Navy, or to such station, as we may be ordered to join, services or duties, and be in everything conformable and obedient to the several requirings and

Secondly, we do also oblige and subject ourselves to serve until we shall respectively a column headed "*Time to which each agrees to serve*," unless sooner discharged by proper autho the United States, in the following words, to wit:

SEC. 1422. That it shall be the duty of the commanding officer of any fleet, squadron, or vessel acting singly, may have occurred on either the Atlantic or Pacific coast of the United States, in some public or other vessel, all enlistment, or as soon thereafter as may be, unless, in his opinion, the detention of such persons for a longer period s the vessel to which they belong shall return to such Atlantic or Pacific port. All persons enlisted without the limi port or in a port of the United States, or they may be detained as above provided beyond the term of their enlistmen of this act, shall be subject in all respects to the laws and regulations for the government of the Navy, until their re officer, or re-entering to serve until the return to an Atlantic or Pacific port of the vessel to which they belong, sha persons who shall be so detained beyond their terms of enlistment, or who shall, after the termination of their enl which they belong, and their regular discharge therefrom, shall receive for the time during which they are so deta former pay: *Provided*, That the shipping articles shall hereafter contain the substance of this section.

And we do, severally, oblige ourselves, during such service, to comply with, and be su established by the Congress of the United States or other competent authority.

Thirdly, and we, whose names are signed in the subjoined column headed "*Signatures o* signatures, in the column headed "*Signatures of Recruits*," are opposite to ours, shall enter t the engagements, and be subject to all the provisions hereinbefore recited; and we hereby r sation for the same.

Fourthly, the said ——— ———, for and in behalf of the United States, does hereby cov as recruits, that they, and each of them, shall be paid, in consideration of such services, the *month*," and placed opposite to each of their names, respectively, or the wages due to the ra of their service aforesaid.

DATE OF ENLISTMENT.			Names.	Rating.	Wages per month.	TIM
Year.	Month.	Day.				Day

DIRECTIONS TO BE STRICTLY OBSERVED BY

These Shipping Articles are to be *signed in duplicate by each recruit, parent, or guardian*, each and every month, to the Bureau of Equipment and Recruiting of the Navy Departme sheet is to contain more names than the number of lines ruled on it. The recruit must sign h the name of the vessel, with the date (day, month, and year), and signature of Commanding

Forwarded to the Bureau of Equipment and Recruiting by—

he Navy until they shall arrive at the age of twenty-one years.

lo, and each of us does, hereby agree to and with ——— ———, of the United States

d, to enter the service of the Navy of the United States, and in due and seasonable time to join, and to the utmost of our power and ability, respectively, discharge our several ngs and lawful commands of the officers who may, from time to time, be placed over us. tively arrive at the age of twenty-one years, being to the time stated in the subjoined er authority, and on the conditions provided by Section 1422 of the Revised Statutes of

singly, when on service, to send to an Atlantic or to a Pacific port of the United States, as their enlistment essel, all petty-officers and persons of inferior ratings desiring to go there at the expiration of their terms of period should be essential to the public interests, in which case he may detain them, or any of them, until the limits of the United States may be discharged, on the expiration of their enlistment, either in a foreign nlistment; and that all persons sent home, or detained by a commanding officer, according to the provisions their return to an Atlantic or Pacific port and their regular discharge; and all persons so detained by such long, shall in no case be held in service more than thirty days after their arrival in said port; and that all their enlistment, voluntarily re-enter to serve until the return to an Atlantic or Pacific port of the vessel to e so detained, or shall so serve beyond their original terms of enlistment, an addition of one-fourth of their

l be subject to, such laws, regulations, and discipline of the Navy as are or shall be

atures of Parents or Guardians," do severally agree and consent that the persons whose enter the service of the Navy of the United States, perform all the services, fulfil all ereby relinquish our claim to the service of such persons, and to any wages or compen-

eby covenant and agree to and with the persons who have hereunto signed their names es, the amount per month which is stated in the subjoined column headed "*Wages per* the ratings which may, from time to time, be assigned to them during the continuance

	Time to which each agrees to serve.			Signatures of Recruits.	Signatures of Parents or Guardians.	Witnesses.
	Day.	Month.	Year.			

VED BY THE COMMANDING OFFICER.

ardian, and the *Commanding Officer*—the original to be forwarded, on the first day of partment, and the duplicate kept among the records of the vessel for reference. No t sign his own name if he can write at all; and the time to which each agrees to serve, nding Officer, must always be written correctly and distinctly.

U. S. S. ———, at ———.

——— ———,

Commanding Officer.

SHIPPING ARTICLES *for the Naval Service, for Persons Enlisting on Sea-going Vessels.*

We, the subscribers, seamen and others, do, and each of us does, hereby agree to and with ——— ———, of the United States Navy, in manner and form following, that is to say:

In the first place, we do hereby agree, for the considerations hereinafter mentioned, to enter the service of the Navy of the United States, and in due and seasonable time to repair on board such vessel of the Navy or to such station as we may be ordered to join, and to the utmost of our power and ability, respectively, discharge our several services or duties, and be in everything conformable and obedient to the several requirings and lawful commands of the officers who may, from time to time, be placed over us.

Secondly, We do also oblige and subject ourselves to serve during the term of ——— years from the time of enlistment, unless discharged by proper authority, and on the conditions provided by the act of Congress "to amend section 1422 of the Revised Statutes of the United States relating to the better government of the Navy," approved March 3, 1875, in the following words, to wit:

SEC. 1422. That it shall be the duty of the Commanding Officer of any fleet, squadron, or vessel acting singly, when on service, to send to an Atlantic, or to a Pacific port of the United States, as their enlistment may have occurred on either the Atlantic or Pacific coast of the United States, in some public or other vessel, all Petty Officers and persons of inferior ratings desiring to go there at the expiration of their terms of enlistment, or as soon thereafter as may be, unless, in his opinion, the detention of such persons for a longer period should be essential to the public interests, in which case he may detain them, or any of them, until the vessel to which they belong shall return to such Atlantic or Pacific port. All persons enlisted without the limits of the United States may be discharged on the expiration of their enlistment, either in a foreign port or in a port of the United States, or they may be detained as above provided beyond the term of their enlistment; and that all persons sent home, or detained by a Commanding Officer, according to the provisions of this act, shall be subject in all respects to the laws and regulations for the government of the Navy until their return to an Atlantic or Pacific port, and their regular discharge; and all persons so detained by such officer, or re-entering to serve until the return to an Atlantic or Pacific port of the vessel to which they belong, shall in no case be held in service more than thirty days after their arrival in said port; and that all persons who shall be so detained beyond the terms of enlistment, or who shall, after the termination of their enlistment, voluntarily re-enter to serve until the return to an Atlantic or Pacific port of the vessel to which they belong, and their regular discharge therefrom, shall receive for the time during which they are so detained, or shall so serve beyond their original terms of enlistment, an addition of one-fourth of their former pay: *Provided*, That the shipping articles shall hereafter contain the substance of this section.

And we do, severally oblige ourselves, during such service, to comply with and be subject to such laws, regulations, and discipline of the Navy as are or shall be established by the Congress of the United States or other competent authority.

Thirdly, the said ——— ———, for and in behalf of the United States, does hereby covenant and agree to and with the said seamen, and others, who have hereunto signed their names, that they, and each of them, shall be paid, in consideration of such services, the amount per month which, in the column hereunto annexed, headed "Wages per month," is set opposite to their names, respectively, or the wages due to the ratings which may, from time to time, be assigned to them during the continuance of their service aforesaid; and likewise to advance to each and every one of them, at entrance, due security for the same being first given, the amounts set opposite their respective names in the columns headed "Wages advanced," and "Bounty paid," the receipt of all which they do hereby severally acknowledge.

☞ Seamen and ordinary seamen enlisted for the Engineer's force, when serving on board of sea-going vessels in commission, are to be rated as first- and second-class firemen, respectively, and are to be paid at the rates of pay established for those ratings. The coal-heavers are to be detailed from the landsmen and paid thirty-three (33) cents per diem, in addition to their regular pay, when steam is up.

Men enlisting under continuous-service certificates will be entitled to receive one dollar per month, in addition to the pay of their respective ratings, for each consecutive re-enlistment for three years, within three months from the date of their discharge.

Term of enlistment.	DATE OF ENLISTMENT.			Signature of recruit in his own handwriting.	Name of recruit written by the officer.	Note if under continuous-service certificate within three months from date of discharge.	Rating.	Note if for duty in the Engineer's force.	Wages per month.	Wages advanced.	Bounty paid.	Signatures of sureties for wages advanced and for bounty paid.	Witness to the signature of the recruit.
	Year.	Month.	Day.										

DIRECTIONS TO BE STRICTLY OBSERVED BY THE COMMANDING OFFICER.

These shipping articles are to be signed in duplicate by each recruit and the Commanding Officer—the original to be forwarded on the first day of each and every January, April, July, and October, and at the end of a cruise, to the Bureau of Equipment and Recruiting of the Navy Department, and the duplicate kept among the records of the vessel for reference. No sheet is to contain more names than the number of lines ruled on it. The recruit must sign his own name if he can write at all, and the term for which he is enlisted must be entered in words and not in figures, in each case. The name of the vessel, with the date (day, month, and year), and signature of the Commanding Officer, must always be written correctly and distinctly.

U. S. S. ———

at ———

———, *Commanding Officer.*

Forwarded to the Bureau of Equipment and Recruiting by—

———.

NAVAL INSTITUTE, ANNAPOLIS, MD.

CORRECTIONS FOR WIND, MOTION OF GUN AND SPEED OF TARGET, AND HOW TO ALLOW FOR THE SAME.

By Lieutenant R. R. Ingersoll, U. S. N.

Among the principal causes of variation in range and deviation in direction of flight of rifled projectiles, independent of the errors of the gun itself, are the influence of the wind and the motion of the gun. The motion of the target, if not allowed for, also affects accuracy of fire.

It will perhaps be admitted that errors in gunnery practice due to the above causes should be eliminated so far as is possible, and that this should be the duty of the officer directing the firing.

In the Ordnance Instructions for the U. S. Navy, Articles 766 to 772, are general instructions in regard to "corrections for speed, wind," etc., and in this paper an attempt will be made to show how these instructions may be carried out in detail, how officers commanding divisions of guns may construct for their use simple tables, by which the sight-bar and sliding leaf may be set to allow for these corrections, leaving the gun captain free to point his gun directly at the target, and to fire when his line of sight and the point to be hit coincide.

In these days of high-powered guns and high speed of modern ships, much valuable time would be lost in trying to find the amount of the corrections necessary to apply to the range and direction of flight by trial shots alone, especially if the guns and target are in motion and if a ship's battery is composed of guns of different calibre and class; and it is believed also that with expensive ammunition, of which but a limited supply can be carried, owing to its weight and the space necessary for stowage, a great saving would result if approximate corrections were applied to the first trial shot, even if the plan was not followed thereafter.

The speed, distance and direction of motion of the target, and the

force and direction of the wind, are subject to the errors of estimation or of observation in any case; and the estimations or observations having been made, the tables, if easy of application, furnish on the one hand a quick and approximately accurate solution of what is largely attempted by guesswork on the other hand.

It is claimed also that by practice officers can soon become very expert in the use of tables to apply corrections, and the time thus expended cannot in these days be used to greater advantage if it will lead to any improvement in gunnery practice.

The mathematical work necessary to show on what foundation the formulae used in the construction of the tables rest, is here given; but it is not at all necessary to a proper understanding of their construction and use.

It must not be supposed that the formulae as finally reached furnish a rigid solution of the problems, but they give a close approximation to the truth, and will suffice for nearly all cases which are likely to happen in firing guns at sea.

Let us now consider in detail the three causes before mentioned.

The Influence of the Wind.

The method followed is that of M. Hélie, Professeur a l'École d'Artillerie de la Marine, in a pamphlet on this subject published in 1874, somewhat abridged.

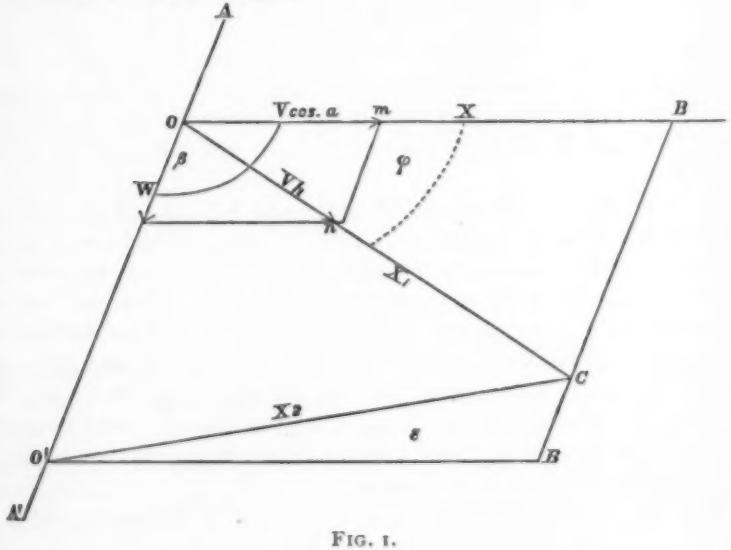


Fig. 1.

Let Fig. 1 represent the horizontal plane passing through the point O.

OB direction of line of fire.

B point of fall of the projectile when the gun is fired in a calm atmosphere and at an angle of elevation α, the gun being at O.

AA' direction of the wind with respect to the line of fire.

$V\cos\alpha$ horizontal component of the initial velocity V.

W velocity of the wind.

Didion in his Traité de Balistique shows that if we suppose the whole system—gun, projectile, atmosphere, etc.—to have a horizontal motion equal to and opposite to that of the wind, that is to say, if in the figure the wind is from $A'O$, if we suppose the whole system to have motion equal to that of the wind and in an opposite sense, the absolute velocity of the wind reduces to zero, and, so far as the relative positions of the parts of the system are concerned, we would have the condition of a calm atmosphere. On this hypothesis we suppose the system to have at the instant of firing a velocity equal to W and toward A' from O, then the projectile on leaving the gun has a resultant velocity of which the horizontal component is V_h, the direction of which is the resultant of $V\cos\alpha$ and W.

At the end of a given time T the projectile will fall at some point C, but the points O and B at the end of the same time have, owing to the motion given to the system, moved to the new positions O' and B', the line OB' parallel to OB, and the relative positions of the gun, point of fall and line of fire will be represented by the triangle $O'CB'$.

The time T, when a very close approximation is desired or when the angle of elevation is large, should be found from a formula in which $T=F(V_1,\alpha_1)$, in which V_1 is the resultant initial velocity. The movement of the system has not changed the vertical component of the initial velocity V and is always $V\sin\alpha$, hence these quantities may be found from the formula $V_1^2=V^2\sin^2\alpha+V_h^2$, and

$$\tan\alpha=\frac{V\sin\alpha}{V_h}.$$

In addition the range X_1 corresponding to (V_1,α_1) should be found.

However, for the purpose of correcting firing at sea, at angles of elevation of 5° and less, which with the new guns will include ranges to at least 4000 yds. and with the 8-in. Converted Rifle to 2800 yds., distances within which naval actions will probably be fought, the

error made by taking T and X as the time of flight and range respectively corresponding to the initial velocity V and elevation α will be very small and may be neglected. On this hypothesis we have, returning to the triangle $O'CB'$,

$$B'C = BB' - BC = WT - W\frac{X}{V\cos\alpha}$$

because $\frac{BC}{W} = \frac{X}{V\cos\alpha}$ from the similar triangles Omn and OBC. Now

$$\frac{\sin\varepsilon}{\sin\beta} = \frac{CB'}{O'C} = \frac{WT - W\frac{X}{V\cos\alpha}}{O'C}$$

or

$$X_2\sin\varepsilon = \left(T - \frac{X}{V\cos\alpha}\right)W\sin\beta.$$

Evidently $X_2\sin\varepsilon$ is the lateral deviation of the point C from the line of fire $O'B'$; and since ε is a very small angle, its sine is sensibly equal to the tangent, and we have

$$\text{deviation} = d = \left(T - \frac{X}{V\cos\alpha}\right)W\sin\beta, \qquad (1)$$

which is the formula given in Brēger, "Probability of hitting an object of any form," translation by Lieutenant C. A. Stone, U. S. N., page 50.

From the triangle OCO' we have

$$X_2 = X_1^2 + W^2T^2 - 2X_1WT\cos(\beta - \varphi).$$

In this equation the term W^2T^2 is so small when compared with X_1^2 that it may be neglected or multiplied by a quantity less than unity, $\cos^2(\beta - \varphi)$, say, and the expression becomes a perfect square; we have then,

$$X_2 = X_1 - TW\cos(\beta - \varphi),$$

and since φ is always a very small angle and becomes inappreciable when β is small, we can without great error write $\cos\beta$ for $\cos(\beta - \varphi)$, and the formula becomes

$$X_2 = X_1 - WT\cos\beta.$$

The time T and X_1 correspond, as has been before explained, to the initial velocity V_1 and the angle of elevation α_1, but for the purpose of approximations affecting firing at sea, within the limits before mentioned, we may use T and X corresponding to V and α, and we have finally

$$X_2 = X - WT\cos\beta.$$

The angle β is considered as a positive angle, and is reckoned from the target on either side of the line of fire around to the rear of the gun.

From (1) and (2) we see that the sign of d is always positive, and that the sign of the second term of the second member of (2) is negative for values of β between 0° and 90° and positive for values between 90° and 180°.

Colonel Maitland, R. A., gives a method for finding the lateral deviation due to the wind, less simple in form than the preceding, as follows, the wind being considered as a constant force blowing across the range, and acting uniformly on the projectile. His method can be used if considered desirable.

Let p = pressure of wind in pounds per square foot.

A = area of longitudinal section of projectile in square feet.

From the computed results of many practice tables he concludes that the expression pA represents with practical accuracy the pressure on the projectile tending to move it from the direction of the line of sight.

Sir Henry James gives the following ratio of pressure to velocity of the wind:

$$p = .005\,V^2 \text{ in miles per hour,}$$
$$\text{or } p = .00232438\,V^2 \text{ in feet per second.}$$

Now if this is a uniform pressure, and if the wind makes an angle D with the line of fire, the path of the projectile will resemble a parabola, and for heavy shot and short ranges or light winds the formula is:

$$d = \text{deviation in feet} = \frac{p \sin D A g t^2}{2\omega}$$

ω being the weight of the projectile.

His formula may be obtained as follows: Let M = mass of the projectile, and f = accelerating force acting on the projectile, then

$$Mf = p \sin DA.$$

or
$$f = \frac{pAg \sin D}{W} = \frac{dv}{dt}$$

integrating
$$V = \frac{pAg \sin Dt}{W} + C,$$

when $t = 0$, $V = 0$ $\therefore$ $C = 0$

$$V = \frac{ds}{dt} = \frac{pAg \sin Dt}{w},$$

integrating
$$S = \frac{p \sin DAgt^2}{2w} + C'$$

when $t=0$, $S=0$ $\therefore$ $C'=0$

hence $$S=d=\frac{p \sin D A g t^2}{2w}.$$

This equation is not accurate enough for light shot and high winds, since a light shot takes up a sideways velocity due to the wind more easily than a heavy one, and ultimately the shot will have the same velocity in that direction as the wind.

It is clear then, that the pressure of the wind on the side of the shot at any instant is that due to the difference between the sideways velocity of the latter and the velocity across the range of the former.

Colonel Maitland thus treats this case: putting V as the sideways velocity of the projectile communicated to it by the wind, we have $W \sin D - V$ as the difference before mentioned, and hence to find the pressure we have

$$p=.00232438\,(W \sin D - V)^2,$$

from the preceding we have

$$f=\frac{dv}{dt}=\frac{pAg}{w}=\frac{.00232438Ag}{w}\,(W \sin D-V)^2$$

$=a\,(W \sin D - V)^2$, when a is a constant for each nature of projectile.

$$\frac{dt}{dv}=\frac{1}{a}\left(\frac{1}{(W \sin D-V)^2}\right);$$

integrating $$t=\frac{1}{a}\cdot\frac{1}{W \sin D-V}+C$$

when $t=0$, $V=0$ $\therefore$ $C=-\frac{1}{aW \sin D}$.

Solve for V, we have,

$$V=W \sin D-\frac{W \sin D}{atW \sin D+1}=\frac{ds}{dt}$$

integrating, we obtain

$$S=W \sin Dt-\frac{1}{a}\cdot \log_e(atW \sin D+1)+C'$$

when $t=0$, $S=0$ $\therefore$ $C'=0$.

Substituting the value of a, we have for deviation in feet,

$$d=W \sin Dt\,\frac{w}{.00232438Ag}\cdot \log_e\left(\frac{.00232438AgW \sin Dt}{w}+1\right).$$

In this formula the first term gives the distance passed over by the wind in the time t, and the second term the space lagged behind by the projectile in that time, and the difference is evidently the sideways travel of the shot.

This last remark applies to the formula deduced after Prof. Hélie's method.

In log-books kept at sea, a table of the force of the wind, pressure in pounds per square foot, corresponding to different velocities of the wind in miles per hour, is given, as follows. The velocity of the wind is measured by an anemometer. It will be found that the pressure agrees very closely with results deduced from Sir Henry James' formula.

Nautical Scale.	Force of the Wind.	Pressure in Pounds per Square Foot.	Velocity of the Wind. Miles per Hour.
0	Calm		
1	Light Airs.	0.004 to 0.019	1 to 2
2	Light Breezes	0.08	4
3	Gentle Breezes	0.4	9
4	Moderate Breezes	1.0	14
5	Stiff Breeze	1.5	17
6	Fresh Breeze	2.0	20
7	Very Fresh Breeze	3.0	24
8	Moderate Gale	5.0	30
9	Strong Gale	8.0	40
10	Very Strong Gale	23.0	67
etc.	Etc.	etc.	etc.

The Motion of the Gun.

In this case the projectile as it leaves the gun is supposed to have a velocity equal to and in the direction of the motion of the gun itself. Now if we can consider the motion in this direction as practically unresisted by the air, an approximate solution is very easily reached.

Professor Rankine gives a formula for the resistance in pounds to bodies moving in a fluid as follows:

$$R = k\rho A \frac{V^2}{2g}, \qquad (1)$$

in which

k = constant determined by empirical formulae or by experiment.
ρ = weight of unit volume of fluid.
A = area of cross section perpendicular to axis of motion.
V = velocity of moving body.

Duchemin gives for a cylinder moving sideways — $k = .77$.

Then if R = resistance in pounds,

f = acceleration or $-f$ = retardation,

M = mass of moving body,

we have $-Mf = R$, and from (1) we have

$$f = -\frac{k\rho A V^2}{2\omega},$$

ω being the weight of the moving body.

To show what the effect would be on an eight-inch projectile $2\frac{1}{2}$ calibres long, $W = 180$ lbs., moving sideways in air with a velocity of 15 f. s. or about 10 miles an hour, we have, taking the weight of a cubic foot of air $= .080728$ pounds, and since the area of the longitudinal section is about 1 sq. ft.

$$f = -\frac{.77 \times .080728 \times 1 \times 225}{2 \times 180} = -.03885,$$

hence the retardation is 0.3885 f. s. $= \frac{dv}{dt}$, whence it may be shown that

$$V = \frac{ds}{dt} = .03885t$$

and

$$S = \frac{.03885t^2}{2}.$$

At a range of 2800 yards, initial velocity 1450 f. s., the time of flight is $7''.11$ $\therefore t^2 = 50.55$ and $S = .98$ foot nearly; for 20 miles an hour, $S = 4 \times .98 = 3.92$ ft. as the approximate errors made at the respective velocities.

The distance actually travelled, taking the resistance of the air into account, being 105.67 and 210.32 feet as compared with 106.65 and 214.30 feet, which would be the distance travelled on the supposition that the motion is unresisted and uniform; the difference is very small, and the resistance of the air for such low velocities may in practice be neglected in the case we are now considering.

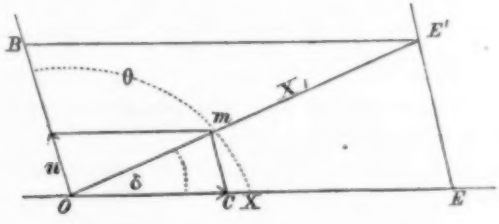


FIG. 2.

On the above hypothesis consider Fig. 2 as the horizontal plane through the point O at which the gun is situated. Suppose the gun

to be moving toward B with a velocity U, and if OE is the line of fire, E being the point of fall of the projectile with an initial velocity V and angle of elevation α when the gun is stationary. And if X is the range and T the time of flight corresponding to these data, and if the projectile during the time T has a uniform velocity in the direction of OB equal to U, then at the end of the time T it will fall at E'; EE' being equal and parallel to $OB = UT$.

The time T and range X can be found from formulae in which they occur as functions of V. α, or may be taken from range tables.

For ranges, then, at angles of elevation less than 5° we may with close approximation take T for a range X that would be given for an initial velocity V and angle of elevation α.

Thus approximating, we have from the triangle $BE'O$, the line $BE' = X$.

$$X_1^2 = X_2^2 + U^2T^2 + 2UTX\cos\theta.$$

But U^2T^2 is very small when compared with X_2^2 and may be neglected or multiplied by a quantity less than unity, $\cos^2\theta$, say, and we have

$$X_1 = X + UT\cos\theta. \tag{3}$$

From the similar triangles OCm and OEE' we have

$$\frac{\sin\delta}{\sin(\theta-\delta)} = \frac{U}{V\cos\alpha} = \frac{UT}{X}$$

or $X\sin\delta = UT\sin(\theta-\delta)$.

Since δ is always a very small angle and vanishes when $\theta = 0$, we may write $\sin\theta$ for $\sin(\theta-\delta)$. Again the sine and tangent of δ are sensibly equal, and if the lateral deviation is $X\tan\delta$, we have

$$d = UT\sin\theta \tag{4}$$

From formulas (3) and (4) we see that the sign of the second term of the second member of (3) is positive for values of θ between 0° and 90° and negative for values between 90° and 180°; θ being taken as a positive angle and reckoned from the line of fire on either side around to the rear of the gun. d is always positive.

THE MOTION OF THE TARGET.

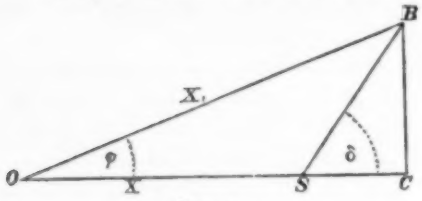


FIG. 3.

Let Fig. 3 be the horizontal plane through OaS.

If the target is at S, Fig. 3, and moving with a velocity U toward B, the line SB making an angle δ with the line of fire OS, the gun being fixed at O. At the end of the time T (T being the time for a shot to travel the range X or OS), the target will have arrived at some point E and $BS = UT$.

Now the gun must be so aimed that the shot will fall at B at the moment the target arrives at that point, hence the sight-bar must be set for a range X_1 and the sliding leaf to allow for a lateral deviation BC at the range X_1. We have $BC = UT \sin \delta$ and $Sc = UT \cos \delta$, and since φ is always a small angle we have approximately

$$X_1 = X + UT \cos \delta \qquad (5)$$

$$d = UT \sin \delta \qquad (6)$$

If d' is the lateral deviation for the range X it will be found practically to differ but little from d, and may be used in its stead.

d is always positive, and the second term of the second member of (5) is positive for values of S between 0° and 90°, and negative for values between 90° and 180°, δ being taken as a positive angle and reckoned from the line of fire on either side around to the rear of the gun.

The formulae may now be collected as follows:

Influence of the wind

$$\begin{cases} X_2 = X - WT \cos B & (1) \\ d = \left(T - \dfrac{X}{V \cos \alpha} \right) W \sin \beta & (2) \end{cases}$$

Motion of the gun

$$\begin{cases} X_1 = X + UT \cos \theta & (3) \\ d = UT \sin \theta & (4) \end{cases}$$

Motion of the target

$$\begin{cases} X_1 = X + UT \cos \delta & (5) \\ d = UT \sin \delta & (6) \end{cases}$$

An inspection of the formulae shows that it will be necessary to construct one table showing the corrections to be made for the

influence of the wind, and that one will suffice to show the corrections to be made for the motions of the gun and target. Each class of gun will require its own set of tables.

The plan is evident, and is simply to assume ranges varying from each other as much as may seem desirable; the lowest range probably not less than 1000 yards, and the highest not greater than that given by the gun with 5° elevation. The initial velocity is given in the Ordnance Instructions, where range tables are also to be found.

Then by formulas (1) and (2) compute for variations of 15° of the angle β, and with a fixed velocity of the wind, say 10 miles per hour, the values of the corrections in range and lateral deviation due to the wind, using the times of flight corresponding to the ranges assumed.

The value of the velocity of the wind is suggested at 10 miles an hour, since for any other values the corrections are very easily found, when once they are computed for that assumed velocity, and the labor of computation is lessened. For the corrections due to the motion of the gun and target the process is the same, except that the velocity of the gun and target should be taken in knots, of 6080 feet each, per hour. When suitably arranged, the amounts of the corrections in range and lateral deviation are found by inspection and interpolation from the two tables for the range at which the gun is to be fired; the other arguments being the angle made by the direction of the wind or direction of motion of the gun and target with the line of fire, and the velocities of the wind, gun and target.

It is suggested that the tables be not made too elaborate, so as to require too much time in searching for the desired corrections. Once determined, the correction for range is applied to the sight-bar with its proper sign, and the correction for lateral deviation to the sliding leaf, or rather they are set to allow for them, and the latter requires a small table to use in connection with it.

The sliding leaf on breech sights is usually graduated in minutes of arc, and the divisions mean simply this, that the distance spaced off on the leaf for a division marked for, say, 40′, is the tangent of an angle of 40° when the radius of the circle is the distance between the front and breech sights. Evidently the distance spaced off is found by taking the circular measure of the small angle in question, the radius of the circle being as before stated. The sine and tangent of so small an angle are sensibly equal to the length of the arc itself. The lateral deviation at any distance, due to the sliding leaf being

moved to the 40′ mark, is found in exactly the same way, for example, the radius of the circle is the given range, then the deviation in yards is the circular measure of the small angle given, or the tangent of that angle when the radius of the circle is the range in yards.

If the sliding leaf is not graduated to minutes of arc there is no difficulty, since the distance of any division from the zero mark may be transferred to a scale by a pair of dividers, and we have then two similar triangles from which the lateral deviation due to the sliding leaf being moved any distance may be found for any assumed range.

For illustration, the necessary tables are computed for the 8-in Converted Rifle, initial velocity 1450 f. s., and the times of flight corresponding to the assumed ranges are taken from the Ordnance Instructions, Range Table for this gun, p. 410.

The ranges are assumed at 1000, 1500, 2000, 2500 and 2800 yards; a greater number, differing less from each other, could be taken with additional labor and space occupied.

In using formula (2) it will be found that V may be used for $V\cos\alpha$ for angles less than 5°. For instance, 5° elevation the range of the 8-in. gun is 2817 yards = 8451 feet. We have $\frac{8451}{1450\cos\alpha} = 5.85$ and $\frac{8451}{1450} = 5.83$, the difference between the two values may be neglected.

Formula (2) then becomes

$$d = \left(T - \frac{X}{V}\right) W \sin\beta.$$

TABLE I.

FOR INFLUENCE OF WIND. 8-in. M. L. R. I. V. 1450 f. s.

R = correction in range, yards. D = correction for lateral deviation, yards.

Velocity of Wind.	Time. Seconds	Range. Yards.	Angle made by direction of wind with line of fire.													
			0° or 180°		15° or 165°		30° or 150°		45° or 135°		60° or 120°		75° or 105°		90°	
			R	D	R	D	R	D	R	D	R	D	R	D	R	D
10 Miles per Hour.	2.23	1000	10.8	0	10.5	.2	9.4	.4	7.7	.5	5.4	.7	2.8	.57	0	0.8
	3.48	1500	17.0	0	16.4	.5	14.7	.9	12.0	1.3	8.5	1.6	4.4	1.8	0	1.9
	4.81	2000	23.5	0	22.7	.8	20.4	1.6	16.6	2.3	11.8	2.8	6.1	3.2	0	3.3
	6.23	2500	30.5	0	29.4	1.3	26.4	2.6	21.5	3.6	15.2	4.4	7.9	4.9	0	5.1
	7.11	2800	34.8	0	33.6	1.6	30.1	3.2	24.6	4.5	17.4	5.5	9.	6.1	0	6.4
20 Miles per Hour.	2.23	1000	21.6	0	21.0	.4	18.8	.8	15.4	1.1	10.8	1.3	5.6	1.5	0	1.6
	3.48	1500	34.0	0	32.8	1.0	29.4	1.9	24.0	2.6	17.0	3.2	8.8	3.6	0	3.8
	4.81	2000	47.0	0	45.4	1.7	40.8	3.3	33.2	4.6	23.6	5.7	12.2	6.3	0	6.6
	6.23	2500	61.0	0	58.8	2.6	52.8	5.1	43.0	7.3	30.4	8.9	15.8	9.9	0	10.2
	7.11	2800	69.6	0	67.2	3.3	60.2	6.4	49.2	9.0	34.8	11.1	18.0	12.4	0	12.8
30 Miles per Hour.	2.23	1000	32.4	0	31.5	.6	28.2	1.2	23.1	1.7	16.2	2.0	8.4	2.3	0	2.4
	3.48	1500	51.0	0	49.3	1.5	44.2	2.8	36.1	3.9	25.5	4.8	13.2	5.4	0	5.7
	4.81	2000	70.6	0	68.2	2.5	61.1	4.9	49.9	6.9	35.4	8.5	18.3	9.5	0	9.9
	6.23	2500	91.5	0	88.3	4.0	79.2	7.7	64.7	10.9	45.6	13.3	23.7	14.9	0	15.3
	7.11	2800	04.3	0	100.8	5.0	90.3	9.6	73.7	13.6	52.2	16.6	27.0	18.6	0	19.2

TABLE II.

Corrections for Motion of Gun or Target.

8-in. M. L. R., I. V. 1450 f. s. R = correction for range, in yards.
D = correction for deviation, in yards.

Speed of Gun or Target Knots.	Yards Range.	δ or θ 0° or 180°		δ or θ 15° or 165°		δ or θ 30° or 150°		δ or θ 45° or 135°	
		R	D	R	D	R	D	R	D
5	1000	6.3	0	6.0	1.7	5.4	3.1	4.4	4.4
	1500	9.8	0	9.4	2.6	8.5	4.9	6.9	7.0
	2000	13.5	0	13.0	3.5	11.7	6.8	9.6	9.6
	2500	17.5	0	16.9	4.5	15.2	8.8	12.4	12.5
	2800	20.0	0	19.3	5.2	17.3	10.0	14.1	14.1
8	1000	10.0	0	9.7	2.7	8.6	5.0	7.0	7.0
	1500	15.7	0	15.1	4.1	13.6	7.9	11.1	11.1
	2000	21.7	0	20.9	5.6	18.7	10.9	15.3	15.3
	2500	28.1	0	26.8	7.2	24.3	13.1	19.9	19.9
	2800	32.0	0	30.9	8.3	27.7	16.0	22.6	22.6
10	1000	12.5	0	12.1	3.3	10.8	6.3	8.8	8.8
	1500	19.6	0	18.9	5.1	17.0	9.8	13.9	13.9
	2000	27.1	0	26.1	7.0	23.4	13.6	19.2	19.2
	2500	35.1	0	33.8	9.1	30.4	17.6	24.9	24.9
	2800	40.0	0	38.6	10.4	34.6	20.0	28.3	28.3
12	1000	15.0	0	14.5	4.0	13.0	7.5	10.6	10.6
	1500	23.5	0	22.7	6.1	20.4	11.8	16.7	16.7
	2000	33.6	0	31.3	8.4	28.1	16.3	22.0	22.0
	2500	42.1	0	40.5	10.9	36.5	21.1	30.0	30.0
	2800	48.0	0	46.3	12.5	41.5	24.0	34.0	34.0
13	1000	16.2	0	15.7	4.3	14.0	8.2	11.4	11.4
	1500	25.5	0	24.5	6.6	22.1	12.7	18.1	18.1
	2000	35.2	0	33.9	9.1	30.4	17.7	25.0	25.0
	2500	45.6	0	43.9	11.8	39.5	22.9	32.4	32.4
	2800	52.0	0	50.2	13.5	45.0	26.0	36.8	36.8
14	1000	17.5	0	16.9	4.6	15.1	8.8	12.3	12.3
	1500	27.4	0	26.5	7.1	23.8	13.7	19.4	19.4
	2000	37.9	0	36.5	9.8	32.7	19.0	26.9	26.9
	2500	49.1	0	47.3	12.7	42.5	24.6	34.8	34.8
	2800	56.0	0	54.0	14.6	48.4	28.0	39.6	39.6
15	1000	18.8	0	18.1	5.0	16.2	9.4	13.2	13.2
	1500	29.4	0	28.3	7.7	25.5	14.7	20.8	20.8
	2000	40.6	0	39.1	10.5	35.1	20.4	28.8	28.8
	2500	52.6	0	50.7	13.6	45.6	26.4	37.3	37.3
	2800	60.0	0	58.0	15.6	51.9	30.0	42.4	42.4
20	1000	25.0	0	24.2	6.6	21.6	12.6	17.6	17.6
	1500	39.2	0	37.8	10.2	34.0	19.6	27.8	27.8
	2000	54.2	0	52.2	14.0	46.8	27.2	38.4	38.4
	2500	70.2	0	67.6	18.2	60.8	35.2	49.8	49.8
	2800	80.0	0	77.2	20.8	69.2	40.0	56.6	56.6

Speed of Gun or Target Knots.	Yards Range.	D	R	D	R	D	R	D	R
		δ or θ 90°		δ or θ 75° or 105°		δ or θ 60° or 120°		δ or θ 45° or 135°	

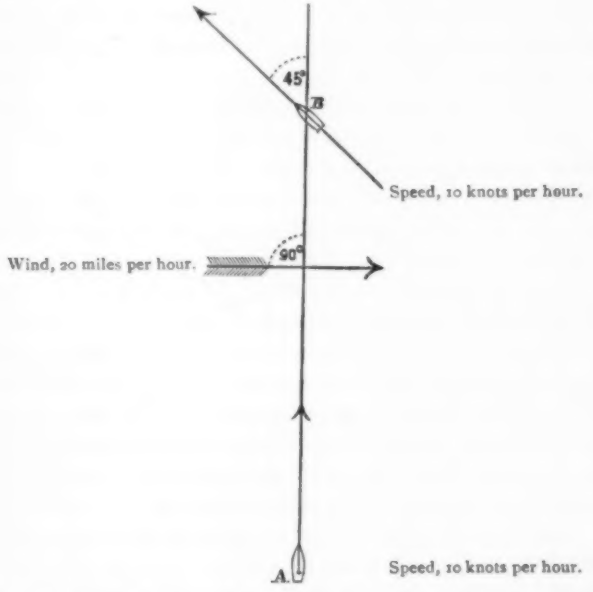
TABLE III.

LATERAL DEVIATION IN YARDS FOR EACH DIVISION ON SLIDING LEAF.

8-in. M. L. R. Distance between Sights 44″.5.

Range Yards.	10′	20′	30′	40′	50′	1°
1000	2.9	5.8	8.7	11.6	14.5	17.4
1200	3.5	6.9	10.5	14.0	17.5	21.0
1400	4.1	8.2	12.3	16.4	20.5	24.6
1600	4.6	9.3	13.8	18.4	23.0	27.6
1800	5.2	10.4	15.6	20.8	26.0	31.2
2000	5.8	11.6	17.4	23.3	29.1	34.8
2200	6.4	12.8	19.2	25.6	32.0	38.4
2400	7.0	14.0	21.0	28.0	35.0	42.0
2600	7.6	15.2	22.8	30.4	38.0	45.6
2800	8.2	16.3	24.4	32.6	40.7	49.2

Example.—Suppose a ship at *A* firing with an 8-in. M. L. R. at a ship at *B*, which is steering a course making an angle of 45° with the line of fire; *A* at the instant of firing steering directly towards *B* and making 10 knots an hour. Wind across the range as indicated in the figure. Distance from *A* to *B*, 1500 yards.



From Table I the lateral deviation due to the wind is found to be 3.8 yards.

From Table II the correction for speed of A is -19.6 yards in range. Correction for speed of B, $+ 13.9$ yards in range, and 13.9 yards lateral deviation. The gun, then, must be pointed to the left of the line of fire to allow for a lateral deviation of $3.8 + 13.9 = 17.7$, say 18 yards, and the sliding leaf should then be set to the left at about the 40′ mark; since from Table III it is seen that that distance on the sliding leaf will cause about the deviation required at 1500 yards range. The range is not materially changed; it is 1494 yards, about.

The table showing the effect of the wind is constructed after Professor Hélie's formulas, as previously deduced, and the lateral deviations seem to be large. It is thought, however, that the results will agree fairly with experiment, but until extended experiments shall be made to establish the law of the deviation of projectiles due to the effect of the wind, any formulas are clothed with some doubt. The writer admits that the tables may, perhaps, be more conveniently arranged than has been indicated, and, doubtless, ingenious officers who care to form and use such tables will devise some better plan of arrangement.

A set of tables, if they serve no other purpose, will give an excellent idea of the magnitude of the correction that should be applied in some way, and, if studied, must lead to an improvement in accuracy of fire.

When a ship is turning quickly, the influence of the *angular* velocity given to the gun on the lateral deviation of projectiles is sometimes a very appreciable quantity. If the lock-string is pulled at the moment the gun-captain decides the line of sight bears on the object to be hit, a short interval of time elapses for the charge to be ignited and the projectile to leave the muzzle of the gun. This interval of time evidently varies with the character of the firing apparatus, the powder, the length of bore or travel of the projectile, and other causes, and it is thought that in many cases may equal, if not exceed, .2 of a second. From experiments made by Lieutenant J. F. Meigs, U. S. Navy, at the Naval Academy, with the Schultz Chronograph, it was found that with the Navy percussion-locks the interval between the gun-captain throwing himself back on the lock lanyard and the explosion of the primer was 0.13 seconds, and to this must be added the time for the charge to be ignited and the shot to leave the bore.

Taking the case of a ship which completes a full circle in 4 minutes

as an example, her angular velocity is 1°30′ per second; and if the interval of time from the moment the gun-captain decides to fire, to the moment the shot leaves the bore, is 0.2, the ship will swing through an arc of 18′ in that time; hence the lateral train of the gun is changed about that much, and by reference to the table for the sliding leaf of the 8-inch M. L. R., this would cause a lateral deviation of 44 feet at a range of 2800 yards. Except at long ranges and when the turning circle is quickly completed, the influence of this source of lateral deviation will probably not be great, especially if a quick-acting firing apparatus be used, and the gun-captains are trained to fire without any delay the instant the sights bear.

While not strictly within the scope of the foregoing article, the following remarks may be pardonable. From a consideration of the magnitude of the errors that are likely to happen from a neglect to apply proper corrections for wind, speed of gun and target, not to mention the motion of the gun platform, the inclination of the plane of the trunnions, the swing of the ship, and other sources of inaccuracy that may occur, we are naturally led to the conclusion that if we expect to attain proficiency in *accurate* gunnery practice, and if we wish to make these modern engines of war perform all they are capable of doing, a most careful and thorough system of instruction and constant practice is an absolute necessity. The idea is here advanced that the men who are to use the sights and attachments intelligently, and to fire the guns with judgment, to say nothing of the niceties of loading and management of the machinery of the carriage and slide, should be of a higher education and attainments than is the case with the enlisted men who are selected for the most important positions of gun-captains. In other words, it is believed that these positions, in want of a *specially trained corps* of enlisted or appointed men, should be filled, for the heaviest guns at least, from trained junior officers of the ship, including lieutenants, so far as they may be available. That they should not be selected according to rank, but according to their skill, good eyesight, a ready knowledge of the requisites for good shooting, and general qualifications for such a position. That officers would esteem such a post of duty in battle as a high honor is not doubted. This arrangement need not exclude the instruction of enlisted men in the duties of such a position, so that they may perform the duty in the case of casualties.

In this way we may, perhaps, gain in increased efficiency of each gun what our navy may lack in the number of guns afloat.

NAVAL INSTITUTE, ANNAPOLIS, MD.

FEBRUARY 26, 1885.

COMMANDER ALLAN D. BROWN, U. S. N., in the Chair.

THE AVOIDANCE OF COLLISIONS ON THE SEA AT NIGHT, AND THE EMPLOYMENT OF DOUBLE SIDE-LIGHTS.

BY COMMANDER W. B. HOFF, U. S. N.

MR. CHAIRMAN AND MEMBERS.

Gentlemen:—I have the honor of calling your attention this evening to a subject, the importance of which, I feel sure, we will all agree to recognize. It is the avoidance of collisions on the sea at night, and in this connection the employment of double side-lights, so that the course of an approaching vessel may be the more readily and the more accurately determined.

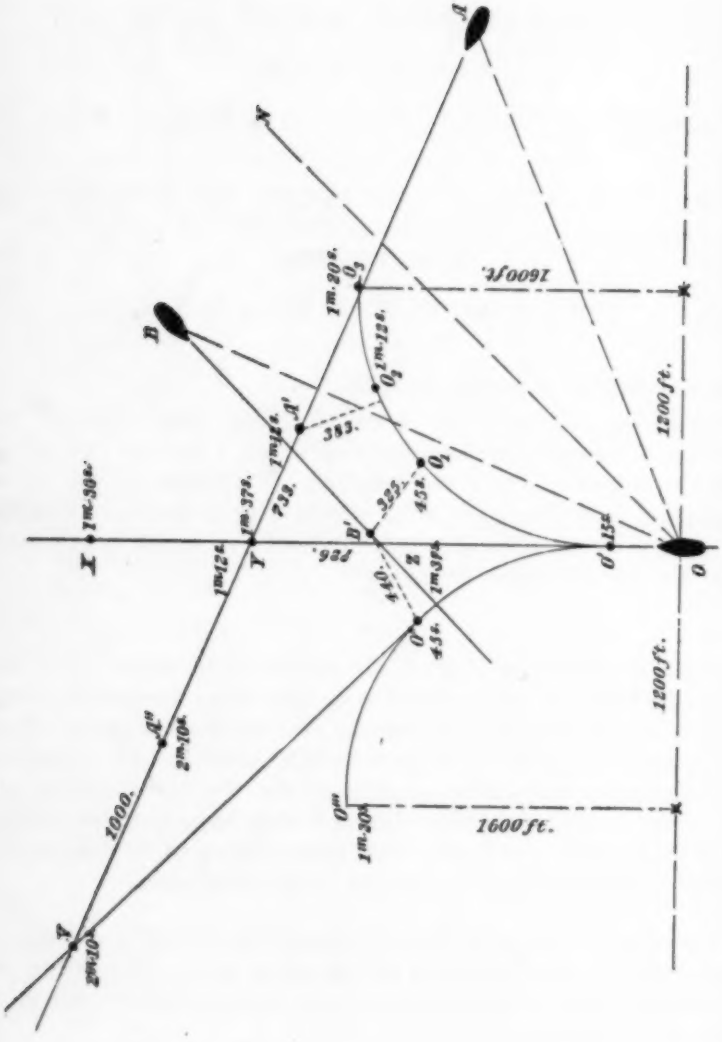
I.

A new Cunarder, the Umbria, has steamed at the rate of twenty and a quarter knots on the measured mile. She is five hundred feet long, and has a displacement of something near ten thousand tons. Here is a condition of affairs on the sea for which we must prepare ourselves, and the first question to be asked is, are the rules of the road as they stand on our statute books applicable to such large steamers, making such great speeds and having such great turning circles, and are the official instructions to pilots in some cases proper ones?

I have here a diagram (Plate 1), where I have laid down to scale the conditions liable to govern two steamers, each moving at the rate of twenty knots, where one would have to manœuvre to keep out of the way of the other.

We notice, first, that *O* is the vessel, under the law, which must give way and avoid a collision with either *A* or *B*, since *O* has them on

PLATE I.


A
B
N
1600 ft.
1200 ft.
1200 ft.
1600 ft.
1m.20s.
1m.12s.
1m.30s.
1m.37s.
1m.12s.
1m.30s.
2m.10s.
2m.10s.
383.
252.
926.
440.
325.
435.
435.
1000.
X
Y
Z
O
O'
O''
O''
O1
O2
O3
A'
A''
B'

his starboard side. *A* and *B* are each half a mile from *O*. Let us for the present consider *B* out of the way altogether, and see what *O* must do to avoid *A*.

The distance *OX* is half a mile, which *O* covers in 1 m. 30 s. *O*'s helm begins to act in 15 s. at *O'*, and she turns through 4 points in 45 s. (making allowance always for loss of speed in turning), when she will be either at *O''* or O_1. She turns through 8 points in 1 m. 20 s., when she will be either at *O'''* or O_2. She has advanced when here 1600 feet, and has transferred 1200 feet.

We see that *A* is in the octant lying between a bearing of 4 points on *O*'s bow and his beam, and we will consider her as standing along the line *AV*.

Now *O* can stand on at full speed; slow, and go astern of *A*; stop, and let *A* pass her; turn to starboard or turn to port.

First, then, if we suppose she stands on to *X* at full speed, she will pass ahead of *A* in 1 m. 12 s. at *Y*, 733 feet, *A* being then at *A'*.

If *O* slowed to ten knots, she would be at *Z* in 1 m. 37 s., when *A* would be at *Y*, where she would have passed ahead of *O* 726 feet.

If *O* stopped, and Professor Osborne Reynolds is correct in saying that she would come to a state of rest in six or seven times her length, independent, or nearly so, of the power developed by her screw when backing, the ship would be somewhere between *B'* and *Y*, dead in the water; time required being between two and three minutes. The chances are that *A* will have by this time passed safely ahead, but it might happen that *O*, not being under control, might, from a false appreciation of *A*'s speed and course, arrive at *Y* just in time to have *A* ram her.

Now suppose that *O*, instead of controlling her speed to clear *A*, used her helm. In the instructions given to pilots, under the present statute, by the Board of Supervising Inspectors of steam vessels, we find that when *O* must manœuvre, the two vessels being situated as in the diagram, she must put her helm to port, and pass *astern* of the other vessel, while *A* must continue on, or "*port her helm*" if necessary. This last instruction is clearly opposed to the International Regulations, which, although not *law*, distinctly state that where one vessel is to manœuvre, the other vessel *must* keep her course.

Now would it be proper to port in this case? I think not. If *O* did she would be at O_2 in 1 m. 12 s., when *A* is at *A'*, and they would have approached one another within 385 feet. Rather close quarters, so close that a slight misjudgment of *A*'s speed on the part of *O*

might make her do the very thing she was trying her best to avoid, *ram A*, since it will be observed that *O*'s course cuts the line along which *A* is standing at O_3.

As we know, there is one thing more that *O* can do, she can starboard her helm and turn to port. Suppose that she does so through 4 points to *O'*. This will take her 45 seconds. If now from here she stood on, at full speed, along the line *O'' V*, she would pass ahead of *A* at *V* (*A* then being at *A''*) in 2 m. 10 s. at a distance of 1000 feet. Of course *O*, after she gets to *O''*, can elect with safety to slow or stop, or use her helm to pass astern after *A* has arrived sufficiently on her bow.

I take it that manœuvre is best which brings about the best results. That is, the vessels being on *safety points*, or those positions where the danger of collision is passed, the conditions governing that movement which makes the separation of these points the greatest distance, and which makes the ships' courses the more nearly parallel throughout the manœuvre, is the best. Therefore I should conclude from the diagram that the best thing for *O* to do is to STARBOARD; and for this reason I term the octant in which *A* is located the OCTANT OF STARBOARD HELM.

Let us now take into account the case of *B* and *O*. We see that *B* lies in the octant *XON*, or on a bearing between ahead and four points on the starboard bow of *O*. *B* is steering a course *BC*, and *O* must manœuvre to avoid her, as in the case of *A*. If *O* and *B* stood on they would collide at *B*, if we considered that their speeds were equal. If *O* slowed or stopped, the same thing might happen, the distance separating them being so short. If *O* starboarded her helm and turned to port she would be at a safety point *O''* in 45 seconds, when *B* was at *B'*, separated 440 feet, and *O*'s keel line at right angles to *B*'s. But if *O* ported her helm, her turning circle lying inside of that of *B*'s course, would be at all times clear of *B*; and although in passing they would come within 325 feet of one another, still their courses would be nearly parallel. The danger of collision can, of course, be lessened by *O*'s slowing. Turning to starboard for *O* is unquestionably the proper course for her to take, and so we can call the angle *XON* the OCTANT OF PORT HELM.

II.

It was not until the autumn of 1864 that the carrying of side-lights of the present system by vessels became compulsory. Almost from

the time that steamers made their appearance at sea, a red light and a green light were carried, but this was without force of law. The only recognized light for vessels at sea was the bowsprit cap-light—a white light—and before this, prudence had dictated a lantern carried forward to show over the ship's side when necessary.

Admiral Ammen suggested in 1860 a light to be carried by sailing vessels on the bowsprit cap. It consists of a lantern divided into three parts. The starboard side green, showing from two points abaft the beam to two points on the bow, or through eight points, the port side showing red through the same arc. That portion of the lantern from two points on the starboard bow to two points on the port bow showed white. Here is what may be said to be the beginning of the system of double side-lights, since there was a danger octant shown. That is, there was a sector of two points on each side of the fore and aft vertical plane shown by the white light.

Undoubtedly as soon as commerce on the sea began, or armed flotillas for war or rapine traversed the waters, the necessity for some means of indicating a vessel's position became apparent, therefore at night a flame of some kind was exhibited. The museums furnish us with many forms of the *cressets* or fire baskets which were carried by the galleys of the middle ages, and later on we come across the elaborate lanterns which adorned the poops of the flagships of the Genoese and Venetian admirals and those of the superior officers of the fleet—works of beauty which might have come from the forge of Quentin Matsys, or from the atéliers of any of the Italian masters of this craft. This state of lighting, white lights forward and lanterns of different colors on the poops, continued until very recently. In the days of the sailing ship an approaching vessel was warned off by a lantern swung over the side. When steamers came in, it became necessary, from the increase of speed and from not having the wind as a factor of normal reference for courses, to show more nearly, by some signal, how a vessel was standing, hence the colored side-lights; so that now-a-days we can tell within ten points how a vessel is steering. But higher speeds exact a more intimate knowledge of the course of the other vessel, and for this reason the suggestions of practical men to gain this knowledge have all pointed one way, the employment of more lanterns. I will not discuss in this paper the means and methods which should be used to insure a good, bright, steady and reliable illumination of the side lanterns, but I shall confine myself to showing you the principal systems designed to accom-

plish the end I have spoken of. I am aware that in order to do this, bad elements as well as good are brought into the question, but I am of the opinion that the *advantages* of using *more* lanterns greatly preponderate.

It may be stated concisely that the disadvantages are greater cost and a greater number of lights to be kept burning, consequently a greater likelihood, in case one of the lights is obscured, that collisions will happen through a wrong appreciation of the vessel's course. The advantage is that we know how the other vessel is steering within less than ten points, and therefore we can proceed at higher speed, while the danger of collision is thus lessened.

Since there are people who are color blind, and since a white light can be seen a longer distance than can one which is colored, there has often been a move made to substitute groups or arrangements of white lamps, and to do away with colored screens. Unfortunately there is much to interfere with this scheme. There is, however, one arrangement which in a way takes in this element, and is the *very best*, but which, it is to be regretted, is not applicable to sea-going vessels. We mean the *range light*, but we will pass by its consideration at present and will discuss it further on.

The white light is the illuminant by which the human eye sees at night; therefore should side-lights be merely some new arrangement in, or repetition of this color, it might happen that circumstances could combine to produce the wrong impression, so that a collision would be courted. Take for instance the suggestion that three white lights, one above the other, should show the starboard side, and that two white lights disposed in the same way should indicate the port side. An accidental putting out or shutting out of one of the starboard lights, something very likely to occur, might give the impression that the port side of the ship was visible to you. Again, a deck lantern improperly exposed above the port light would lead you to suppose that you saw the vessel's starboard side.

In my opinion, this possibility would more than offset any error liable to arise from color-blindness. If the side-light—either a red one or a green one—was extinguished, although a collision might occur from the fact that the ship approaching was not seen, still there could be no *misleading* as in the case of white side-lights.

From what has now been said I think that we are confined to *colors*, and I am of the opinion that the solar spectrum does not furnish any others more distinctive than those now used.

III.

Methods have been devised to show how the helm is put, by means of signal lights being displayed to the other ship. In one system for steamers a whistle is also automatically blown to show the condition of the helm. In another system the way the helm is put is shown by a second side-light, perhaps of a different color, surmounting the regular side-light. These ideas as regards lights are all fundamentally vicious, all equally bad. Imagine the confusion likely to arise by a green light appearing in company with a red one, or a red light surmounting a green one!

Should it become necessary to apprise an approaching vessel of the state of your helm, nothing is better than the blasts of the steam whistle as now laid down, and which in my opinion should be incorporated in the international rules of the road.

Since the year 1871 all steam vessels whose cruising is confined to sounds, bays, estuaries and rivers of the United States, have, in addition to the ordinary lights carried by vessels at sea, displayed a white light on a pole at the stern, to show above the white light at the bow. This range-light, as it is called, shows unobstructedly around the horizon. The lights now carried are, as we know, two colored side-lights, green to starboard and red to port, showing from ahead to two points abaft the beam on each side, through ten points, and which are invisible half a point on the other bow. As we know, this is the outfit for sailing vessels, and for steamers we add the masthead white light, showing through twenty points from ahead through ten points on each side. When we add the white range-light aft, which shows all around the horizon, we have a vessel ideally lighted. I can think of no better way, since every change of direction is immediately shown. But unfortunately its use is not applicable to the open sea. The drawback being that it cannot be seen when sail is set; again, smoke and the large tops in men-of-war, now larger than ever, since mechanical gun fire from aloft is necessary, interfere with its efficiency; but the principal reason is, that the rolling of the ship destroys the range, and so we reluctantly leave it to look at some of the substitutes furnished us to gain this end. This is generally brought about by the employment of more than one light of the same color, or of different colors, on the same side of the vessel, which arrangement is generally known by the name of Double Side-Lights. But there are some systems which have this object in view, and at

which we intend to give a passing glance, where the side-lights as now fitted are disposed in some regular figure, any change in which shows a change of course for the ship.

There is one, for instance, where the side-lights and mast-head light are arranged in an equilateral triangle in a plane parallel with the midship section. The advantage of this system is that the course of the vessel is indicated nearer than ten points, by the practiced eye marking the angle made by a line passing through the mast-head light and one of the side-lights and the horizon. The disadvantage is that the mast-head light would generally have to be carried too low, or else the side-lights would have to be carried on outriggers, and therefore the plan is hardly feasible.

Another method is to have the mast-head light carried so far aft of the side-lights that when the ship presents a beam view, a line passing through the mast-head light and one of the side-lights makes an angle of 45° with the horizon, and when the eye of the observer is four points on the bow the mast-head light is right over the side-light. The plan, if it were practicable, would be fairly good, but generally vessels are so sparred and rigged that it cannot be done.

Admiral Ammen suggests that steamers carry the ordinary side-lights, and his light for a mast-head light. This would be in many ways an improvement, and I regret that I cannot show it on my model, with which I hope to demonstrate to you practically this evening the value of the systems I am now bringing to your notice. If there is any drawback to this method it will be found, I fancy, in the sails, smoke and top-hamper obscuring it and making the colored shades non-effective.

IV.

One of the first to present a system of double side-lights was Captain von Littrow. Here is a diagram which shows his method (Plate II, Fig. 1). It will be noticed first, that neither of his lights shows abaft the beam. There is a light of the proper color on each side, showing from ahead to abeam, and in addition to these side-lights there are other side-lights of the same color, showing, through an arc of four points, from four points on the bow to abeam. These second lights are placed as far aft as possible. All these side-lights are in the same horizontal plane. It will be easily seen that the ship's course with this system of lighting is more closely known. If one light is seen, the ship is heading within four points of a course which

PLATE II.

Fig. 1.

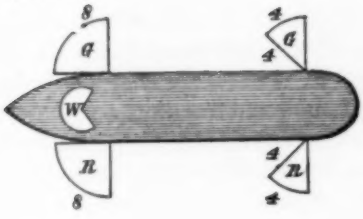


Fig. 2.

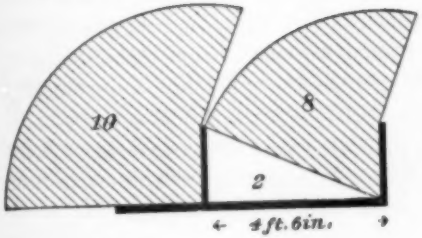


Fig. 3.

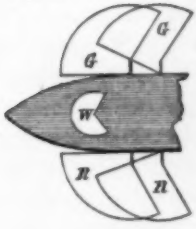
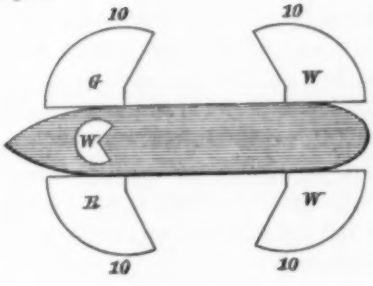


Fig. 4.



is the opposite of your bearing from her. If two lights are seen, the ship is heading between four points and eight points of the direction you are bearing from her.

Now the disadvantage of this arrangement of lights is that the lights being separated as far as possible and being on the same horizontal plane, the conditions in a long steamer would be such that she might be mistaken for a steamer and a sailing vessel astern of her.

As regards distances between lights, we see here (Plate II, Figs. 2 and 3) a plan almost the opposite of the foregoing, the two lights being arranged in the same light-box only 4 feet 6 inches apart, and on the same horizontal plane. This system is the invention of Mr. George Tracy Parry, of Philadelphia. A Naval Board reported last April that they had had practical workings with it on the Delaware River, and had found that the lights were too near together. This we can easily see is the case, and since they are both in the same horizontal plane they blend at even short distances. Again, although the most dangerous sector, the two-point sector, is shown by *one* light (and I would call your attention to the fact that this is a good point), supposing that each light could be seen for itself if we were within the illuminated arcs; still, outside of this the ship's course is not known within eight points, since the after light shows through this many points.

Let us next look at the system proposed by Señor Giralt—a Naval Instructor in the Spanish Navy (Plate II, Fig. 4). Although his idea is something rather different from double-side-lights, still, in the arc extending from two points forward the beam to two points abaft the beam, two lights, a red and a white, or a green and a white, are seen, and the vessel's course may be said to be indicated within four or six points. This method of lighting was intended to furnish additional safeguards to navigation, and was contrived to show one ship, overtaking another, the presence of the leading ship. In other words, a vessel's lights were to be seen from every point of the compass. These are really good points for a system of lighting to possess, but the accidental showing of a white light—a deck lantern for instance—abaft the red might lead another vessel to suppose that safe courses were being steered when in fact a collision was imminent. This alone would do away with all possible good of such side-lights as these. Vessels stopped, with the likelihood of being rammed in the stern by an approaching steamer, would do well to have a light waved over the stern, but I do not think that there would be any use to habitually illuminate ships in this way.

The system of Captain Manzanos of the Spanish Navy next claims our attention (Plate III, Figs. 3 and 4). Here is a second light in range, which shows through six points, between one point on the bow and one point forward of the beam. This light is elevated any height above the after one, which has the common arc (ten points) of illumination. Now it will be noticed that one light will be seen by an observer located on a bearing half a point forward the beam of the ship (which will then be crossing the other's bows, and each will be safe from the other); and that the same conditions of only seeing one light will take place when the observer is located half a point on the bow of this vessel, when each will probably be in imminent danger of collision. Again, two lights being seen, the distance between them being arbitrary, where this was small, as in a short ship, it might have the appearance of a larger ship steering a course heading more nearly for you. This might or might not add to the danger of a collision, but it would certainly add to one's perplexity.

I think all the advantages of double side-lights appear in the system which I submitted to the Bureau of Navigation of the Navy Department in 1883. Here it is! (Plate III, Figs. 1 and 2). We have the ordinary side-lights forward, and twenty metres directly abaft them and at two metres elevation, a side-light on each side, of the usual color to show from ahead to four points on the bow. The distance between the lights, and the height of the after-light above the forward-light, are *invariable* for every vessel. It will be observed that two lights will be visible when the vessel is steering for you within four points; also, that the range is preserved throughout and is properly made, the after-light being the higher, and not as in the system of Captain Manzanos, where the contrary is the case. Then again, the lights being always the same distance apart, both in the vertical and horizontal measurements, and that distance being sufficiently great to prevent blending, and small enough to make the system applicable to small steamers, the eye will become accustomed to the angles subtended by the two lights for the different courses steered by the ship, so that I fancy the direction in which the vessel is standing, whose two lights are seen, can be determined within one point. I am also of the opinion that all the bad qualities inherent in the other systems are overcome in this. If we turn to this diagram (Plate IV), I think we will discover the advantages of this method. You will remember that at an early stage of this paper we called the octant which corresponds to *A* the octant of starboard helm, and the

PLATE III.

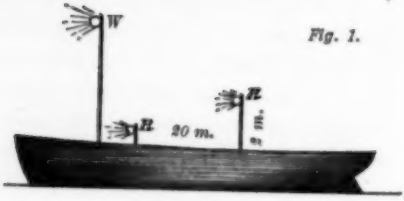


Fig. 1.

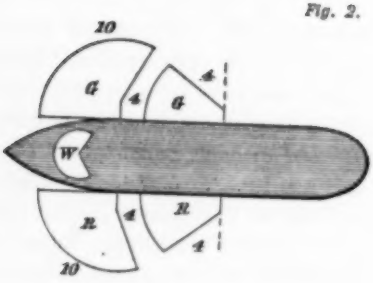


Fig. 2.

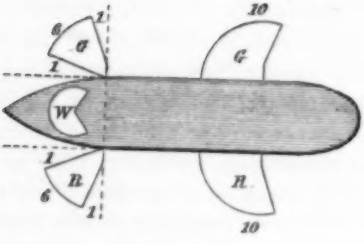


Fig. 3.

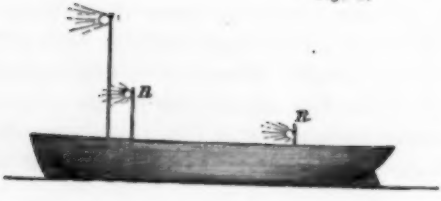
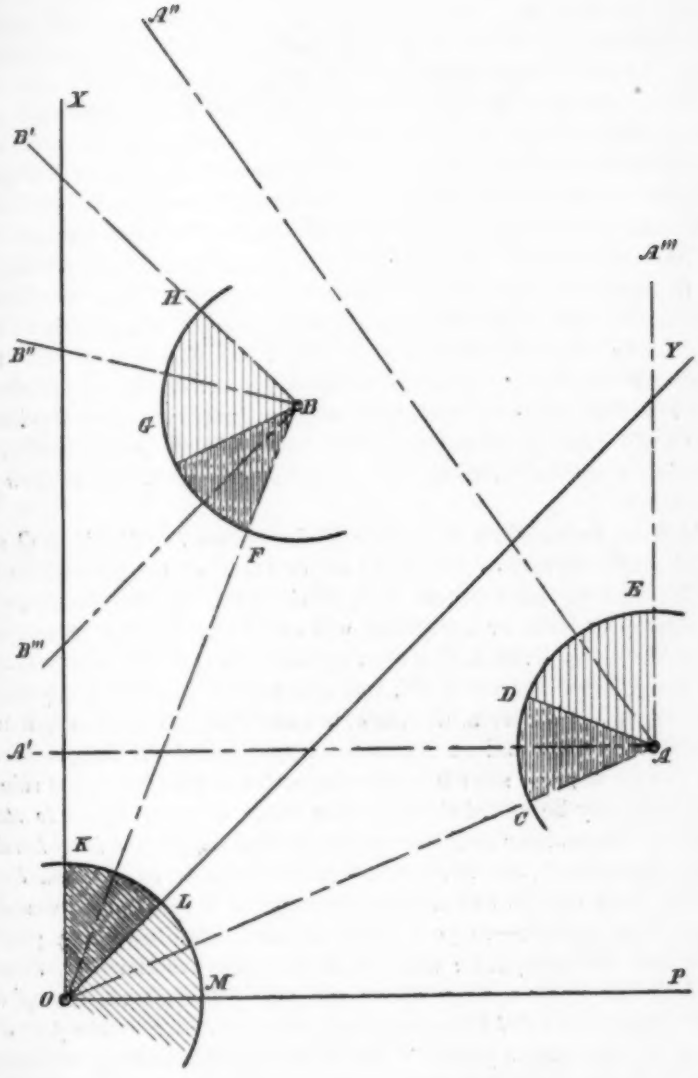


Fig. 4.

PLATE IV.



octant which corresponds to *B* the octant of port helm. Now, the positions in this diagram are precisely the same as regards bearing as those which occur in Plate I, and *O*, which is steering a course *OX*, must manœuvre to avoid collision. First, let us consider *A*. If two lights are seen, *A* must be steering for you, as we have said, within four points, or somewhere in this darker shade between *DA* and *CA*. Her general course will be along the line *AA'*, and the distance she must make to collide with you is so great that you could certainly go ahead of her without danger, or at most you would have to ease the slightest off to starboard, supposing, of course, that the speeds of both vessels are considered as equal. Now if only one light is seen, then *A* is steering somewhere between four and ten points of your bearing, in this lighter shade, or between *DA* and *EA*, in the general direction *AA''*; or your courses, in other words, are converging, and therefore the danger of collision is probable on the other side of *X* on the line *OX*. So I call this octant *YOP* the *danger octant for one light*, or, to lay down a rule: *When you make one red light in the octant between four points on your starboard bow and a bearing abeam, use your starboard helm to avoid collision, turning completely round and going under the vessel's stern if necessary.*

Now let us consider *B*. Here if she shows *two lights* to *O* she will be steering somewhere in the sector *GFB* on the general course *BB'''*. As we have before said, *O* should port immediately, and slow, stop or back, or a collision will occur about *B'''*. If only *one light* is seen by *O*, then *B* is steering somewhere in the sector *GBH* on the general course *BB''*, and will certainly clear *O*, especially if *O* slows. A collision, therefore, is most likely to occur when two lights are visible, and so I call the octant *XOY* the *danger octant for two lights;* and since it is also the octant of port helm, the rule of the road may be stated thus: *If you make two red lights to starboard, between ahead and four points on the bow, put the helm hard to port immediately, and if the lights look near, slow or stop and back.*

I do think though that it would be better if *B* in this case was also made to manœuvre—to port *her* helm and turn through 4 points. It would not complicate matters, as the rule would read: *Vessels making two lights between ahead and four points on the bow of the other color than what they show, must put their helms hard-a-port and turn through enough points to shut in one light, slowing if necessary.*

It might be urged in opposition to what I have said that the duty

would be so divided that in case of collision the blame could not be attached to either; but we know that under all circumstances the *other* vessel did the wrong thing, and there would be as much of a chance for a court to decide under the rule I have laid down as there is now.

I wish now to say a word upon a subject which formed the basis of a communication I had the honor to send the Department.

The fact cannot be ignored that as a nation we are not sea-faring. In the old days, before the newer portions of our country were accessible, the spirit of adventure sought the sea as the theatre of his exploits. In case of war now—and it will be a naval war—we will not have the same hearty emulation as existed in 1812 between the hardy fishermen of Massachusetts Bay and the Gulf of Maine, the dexterous pilots of the Delaware, said to be the best sailors in the world, and the daring men of the Chesapeake, but we will find ourselves almost without trained men of the sea. True, we can find plenty who follow the various sea-trades, the stoker, the fireman, the boatman, and the man aloft; but the skilful steersman, the trained lookout, are wanting, and so I conceive that we must lose no time in gathering together and educating material which will be needed at the very outbreak of hostilities.

In my opinion this condition is best met by recognizing that there is, beside the seaman gunner, a co-ordinate outgrowth for the Naval apprentice, the *intelligent Helmsman*, who is developed through the *Signalman*. I will not weary you with the requirements of the different grades into which he is put, how he is paid when there, and under what circumstances he goes from grade to grade, according to his attainments in the line of study I have laid down, or how he must be neither short-sighted nor color-blind; but I will say that the course goes systematically, from holding a deck lantern properly to understanding all sorts of signals, including those made by electricity. Now while the Signalman is in this school, he is being developed coördinately all the time, and he becomes in turn the messenger, the quarter lookout, the lee helmsman, the leadsman, the bow lookout, the weather helmsman, the Coxswain and the Quartermaster. These conditions being fulfilled, our navy could be expanded at pleasure, since vessels could be commissioned and go immediately to sea with men whose training brings the handling of the vessel to the highest standard, and diminishes to a minimum the chances of collision.

Before closing this lecture and showing you how the systems we

have been discussing look upon the model I have here with me, I would say that since such a bad state of affairs exists as regards rules of the road and the lighting of ships, which together with color-blind and short-sighted people add needlessly to the dangers of navigation, would it not be well for us as a nation to call upon maritime powers to join us in a Congress to which these things will be referred? I feel certain the necessity exists, and the sooner we get about it the better. In conclusion, I can only urge upon the members of this Institute and others who are here this evening, to use all their influence in this direction, and in conclusion, to permit me to thank them for their kind attention.

NAVAL INSTITUTE, ANNAPOLIS, MD.

GRAPHICAL METHOD FOR NAVIGATORS.

By Commander C. D. Sigsbee, U. S. N.

For Star Identification, Great-Circle Sailing, True Bearings of HeavenlyBodies, Hour Angle and Altitude of Bodies on the Prime Vertical, and, in general, for the Approximate Solution of Spherical Problems.

Introduction.

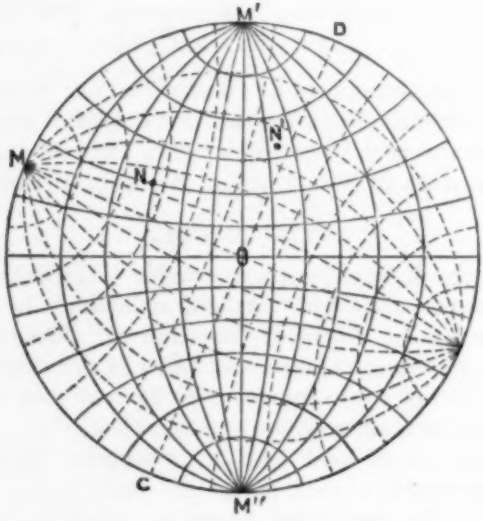
The appended diagram is a stereographic projection of the sphere containing great circles and parallels, at intervals of one degree, for the measurement of spherical coördinates. The novelty of the graphical method consists in the adaptation of this single projection, or system of circles, to the measurement of more than one system of coördinates in the solution of the same problem.

In the figure on the next page let us suppose that the full lines, consisting of a system of great circles and parallels, with M' and M'' as the poles of the latter, have served to project the points M and N, the coördinates of which are given.

Let us suppose, further, that M is one of the poles of a similar set of parallels in combination with a similar set of great circles, and that to this system of dotted lines — which serve for the measurement of another system of spherical coördinates—the point N is to be referred for the solution of a problem.

To make the explanation more practical, let us assume, 1st, that the full lines consist of vertical circles, or circles of azimuth, and parallels of altitude; the *primitive*, or bounding circle, being the meridian of the observer, M' his zenith, and that, having the azimuth and altitude of a heavenly body given, we have projected its place, N, upon the figure; 2d, that M is the elevated celestial pole, the dotted lines hour circles and parallels of declination, and that we require the hour angle and the declination of the body at N.

If the graduations of the primitive and of the dotted diameter or equinoctial, CD, were properly numbered we would simply have to note the parallel of declination and the hour circle passing through the point N, follow one to the primitive and the other to the equinoctial, and take readings, in order to find the declination and the hour angle of the body, that is to say, the coördinates of the point N according to the system of coördinates measured by the dotted lines.



So long as the relative positions of the two points, M and M', remained the same, such a figure would serve for the solution of similar problems involving any other position of an interior point N; but, since the relative positions of M and M' are constantly changing in practice, no two sets of lines similar to those of the figure and printed upon a single sheet can be of universal application in the manner described. The object of the writer's method is to overcome this difficulty by adapting the system of full lines to serve the purpose of both systems for all positions of M and N.

The position of N with respect to the dotted lines is defined by its position relative to the points M and O. Since the two systems of lines are similar, if we transfer N to N' so that N' shall have the same position with respect to M' and O that N has with respect to M and O, then N' will have the same relation to the full lines that N

has to the dotted lines, and we may therefore let N' represent N, and the system of full lines, in connection therewith, represent the system of dotted lines.

Briefly, then, the method is to first assume that the full lines represent a system of spherical coördinates to correspond with given data, and then to project M and N; next to transfer N to N', and then to assume that the same lines represent another system of spherical coördinates to which it is necessary to refer N' for a solution. Article I explains the graphical method.

While stereographic projection has long been used for the graphical solution of problems in nautical astronomy, by making a special projection of each case, the writer is not aware that any method has ever before been devised by which a single projection is made generally applicable for solutions.

Methods which are similar, to the extent that they adapt prepared stereographic projections to general use to avoid drawing, have been devised by Chauvenet and by Saxby, but both of these methods employ more than one projection or diagram for the purpose.

The writer has never seen Saxby's Spherograph, but it is described in several successive numbers of the *Nautical Magazine* (English) for 1856. It consists of two concentric projections, each capable of being revolved about a common pivot at the center, one being transparent. It appears that different sets are employed for different purposes. Judging from the description, it is a less perfect device than Chauvenet's.

Chauvenet's Great-Circle Protractor was formerly issued by the U. S. Hydrographic Office, but it has now become rare. It consists of two concentric projections, one fixed and the other revolving about a pivot at the center. The revolving one is transparent. These projections, which are precisely the same, are on the plane of the meridian like that employed by the writer. The transparent card is objectionable, because it becomes more or less opaque and very brittle in time. In some relative positions of the two projections the maze of lines is such as doubtless to prove an obstacle to its use by those who do not understand the principles on which the Protractor is based, otherwise it is difficult to conjecture why a device so simple in conception has fallen so completely into disuse. Strange to say, Chauvenet gave an imperfect rule for finding the vertex of a great circle upon his Protractor; he overlooked the fact that the vertex is at 90° difference of longitude from the point where the great circle crosses the equator.

The writer has adapted his own method to orthographic as well as stereographic projection, not with a view of publication, but simply as an interesting study. In fact, he had no intention to publish it in any shape until urged to such action by some of his brother officers.

The method now published is exceedingly simple, and is correct in principle; but accuracy of result depends upon the precision attained in projecting points and in reading from the graduated scales. A person of only ordinary skill will doubtless be able to project and read to one-quarter of a degree in most cases, which may perhaps be regarded as excessive accuracy for great circle courses, and sufficient for true bearings. The diagram in the size given does not serve to find the longitude from a "time sight," because a result to the nearest minute is sought; but for the partial determination of Sumner lines it suffices, as will be shown. For star identification it is especially well adapted, as the stars used by navigators are separated by considerable angular distances. It is cheaper, more compact and more easily lighted than a celestial globe, and affords more accurate measurements than ordinary globes of the same diameter.

Although only the general knowledge of nautical astronomy possessed by every navigator is requisite to solve the problems given herein, a better acquaintance with that subject will enable those using the method to greatly extend its application upon the diagram.

The writer does not, in a general sense, recommend his method as a substitute for computation; he simply submits it as a legitimate means of solving certain problems which may be more acceptable to those who prefer graphical methods when they can be employed to advantage, and also as offering in its applications a wide range for study. He believes, however, that a beginner in navigation, especially one with but little acquaintance with mathematics, can gain an intelligent working knowledge of the problems given incomparably quicker by his method than by computation.

A diagram like that given herewith is being prepared for publication by the U. S. Hydrographic Office, under the direction of Commander J. R. Bartlett, U. S. N., Hydrographer, who has consented to this advanced publication. That diagram will be printed for issue on both sides of a heavy Bristol board, and the board will then be coated with a thin, transparent mixture known as "ivorine." Pencil marks may be easily erased from the "ivorine" surface. The following pages are copied from the manuscript prepared for the

Hydrographic Office. Although much of the matter is elementary to members of the Naval Institute, it is deemed best to treat the subject as if for general publication.

General Graphical Method.

Article I. The following elementary, graphical process forms the basis of solutions; its special application to each case is explained in its proper place. See sheet containing the diagram.

Figure 1. Having projected upon the diagram two points, as M and N, given in position, one upon the primitive, or bounding circle, and the other within, conceive a sector MOC whose radii OM and OC shall include these points. Conceive this imaginary sector to be revolved about O until M coincides with some other given point upon the primitive, as M'; then find N' the revolved position of N. *The radii need never be drawn.*

There are various ways of finding N', but the following are suggested. The first is always available, and involves marking points only upon the diagram; the second requires a piece of tracing paper, but makes no marks whatever upon the diagram.

Since one case embraces all, let it be required to revolve the sector MOC about O until M coincides with M', and find N'. Since M will traverse the arc MM', the point C will traverse an equal arc CC'.

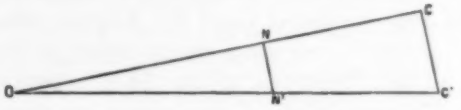
1st Method. Align a straight-edge on O and N to find the point C. Make the arc CC' equal to the arc MM' either by the divisions upon the scale of the primitive, or by transferring the chord MM' to CC' with a slip of paper. Align a slip of paper on O and C and mark upon it the points O, N and C. Then align the slip on O and C' so that its marks O and C shall coincide with O and C' of the diagram, respectively. The point N of the slip will be N', the revolved position of N.

2d Method. Lay a piece of tracing paper (or, as a makeshift, writing paper greased and rubbed thoroughly dry) upon the diagram and trace the points M, O and N. Revolve the tracing about O until M coincides with M'; the traced point N will fall at N'.

In the explanatory Figures 1 to 8, lines of the diagram are represented by full lines, imaginary and traced lines by dotted lines. *Although letters of reference are used the rules are general.*

The diagram should be kept dry because it is intended to be an exact circle. Should it become eccentric so that one radial line, as

ONC (Fig. 1) will be of a different length from another, as *OC'*, to find upon the latter the revolved position *N'* of the intermediary point *N*, proceed as follows, referring to the figure below: from some point, as *O*, on a slip of paper draw lines duplicating the lines *ONC* and *OC'* of the diagram, making any convenient angle with each other. Join *C* and *C'*, and through *N* draw a parallel to *CC'* cutting *OC'* in *N'*. Then use the line *ON'C'* instead of the line *ONC*.



To find the Name of an Observed Star.

Article II. Frequently a star favorable for observation cannot be referred to the surrounding constellations because of cloudiness, and therefore cannot be identified. In such a case measure the altitude as usual, noting the Greenwich time. At the same time, or immediately afterwards, take a compass bearing of the star. Correct the observed bearing for variation and deviation, and reckon it from north in north latitude and south in south latitude; this will give the star's azimuth or true bearing near enough for our purpose. Correct the altitude. Find the latitude and longitude by account, and the local mean time of observation by applying the longitude in time to the Greenwich time of observation. A navigator will always know his latitude and longitude near enough.

Graphical Solution.

The diagram is first assumed to be a projection of the celestial sphere composed of azimuth circles, or vertical circles, and parallels of altitude. *M'* is the zenith, and the line *AB* the celestial horizon. The primitive is the celestial meridian of the observer.

Figure 3. With the azimuth inspect the scale of *AB*, and reckoning from either extremity, find the star's azimuth circle.

With the true altitude inspect the scale of the primitive, and reckoning from either extremity of *AB*, upwards, find the star's parallel of altitude.

The projected place, *N*, of the star is at the point where its azimuth circle intersects its parallel of altitude.

Reckoning from the same extremity of AB as in finding the azimuth circle, find upon the primitive, above AB, the point, M, corresponding to the latitude. M is the place of the elevated celestial pole.

Conceive a sector, MOC, whose radii shall include M and N. Revolve the sector about O until M coincides with M'. Find N', the revolved position of N (Article I).

The diagram is now assumed to be composed of hour circles and parallels of declination. M' is the elevated pole, AB the equinoctial, or the celestial equator, and N' the place of the star.

Read the declination upon the primitive at the parallel of declination passing through N', reckoning from the nearer extremity of AB. When the parallel is above AB, the declination is of the same name as the latitude; when it is below AB, the declination is of the contrary name to the latitude.

Take the reading upon AB at the hour circle passing through N', reckoning from the extremity of AB opposite to that from which the azimuth was reckoned. Convert the degrees and minutes into time. This time will be the hour angle of the star east or west of the meridian according as the star is observed east or west of the meridian.

Having the hour angle, find the star's right ascension by the rule given below, then scan the star tables of the Nautical Almanac and find the name of the star having (approximately) the given right ascension and declination.

To find the Star's Right Ascension. To the right ascension of the mean sun (Nautical Almanac, page II), corrected for the Greenwich mean time of observation, add the local mean time. The result will be the sidereal time. If the hour angle of the star is east of the meridian, add the hour angle to the sidereal time, or if west of the meridian subtract it from the sidereal time, and we have the R. A. of the star, that is:

Star's R. A. = Sidereal time $\pm$ Star's H. A.

or, Star's R. A. = R. A. mean sun + L. M. T. $\pm$ Star's H. A.

Example.

The method of solution is shown in Figure 3, which represents the diagram.

At sea May 10, 1884, P. M.; latitude 27° 15′ N., longitude 89° 30′ W. True altitude 43° 15′, corrected compass bearing or azimuth N. 110°

W., Greenwich M. time of observation 13h. 12m. Right ascension of the mean sun for Greenwich time, 3h. 16m. 56s. The star is Procyon, whose tabulated right ascension is 7h. 33m., declination 5° 30′ N.

In Figure 3, AE is made equal to the azimuth of the star, and the arc BL to its altitude; then $M'E$ is the azimuth circle of the star, LL is its parallel of altitude, and N is its projected place. AM is made equal to the latitude, then M is the place of the elevated pole. MOC is the sector.

$M'OC'$ is the revolved position of the sector, N' the revolved position of the star, and M' the revolved position of the elevated pole. $M'F$ is then the hour circle and DD the parallel of declination of the star. BF is the measure of the hour angle $BM'F$, and BD of the declination.

To find the Hour Angle and Altitude of a Heavenly Body on the Prime Vertical.

Article III. If its declination is greater than the latitude, a body does not cross the prime vertical; if less, it crosses above the horizon if of the same name as the latitude, below if of the opposite name. Any case may be solved by the diagram; but the passage above the horizon being the one of practical use to navigators, the directions which follow are intended for that case.

The data required for effecting a solution are the approximate latitude and longitude of the place of observation and the approximate declination of the body.

Hour Angle. The angle obtained from the diagram is the hour angle of the body east or west of the meridian, according as the time of east or west passage is sought. In the case of the sun, therefore, when converted into time, it is the local apparent time of west passage; and its difference from 12 hours is the local apparent time of east passage. In the case of any other body, to find the *time* of passage apply its hour angle in time to the time of the body's meridian passage.

Graphical Solution.

The diagram is first assumed to be a projection of the celestial sphere composed of hour circles and parallels of declination. M' is the elevated pole, and AB the equinoctial, or the celestial equator. The primitive is the celestial meridian of the observer.

Figure 4. With the declination inspect the scale of the primitive, and, reckoning from either extremity of AB upwards, find the parallel of declination of the body. Similarly, find the point M corresponding to the latitude. M will be the zenith of the observer.

A right line OM will be the upper branch of the prime vertical, and its intersection, N, with the parallel of declination will be the point of transit.

Read the hour angle upon AB at the hour circle passing through N, reckoning from that extremity of AB which is adjacent to M.

Since the time of passage is now known approximately, if the latitude and longitude are accurately known, greater accuracy of solution may be attempted if desired. Having the local apparent time and the longitude in time, find the Greenwich Mean, or apparent time, to which reduce the declination of the body. With the corrected declination, repeat the operation upon the diagram. This repetition is not likely to be needed excepting when the latitude and declination are nearly equal, especially when both are small; *i. e.* when the prime vertical OM intersects the parallel of declination at an acute angle.

To find the altitude, revolve the imaginary line OM about O until M coincides with M', and find N', the revolved position of N; that is, make ON' equal to ON with a slip of paper.

Now assume that the projection is composed of vertical circles and parallels of altitude. AB is the celestial or rational horizon, M' the zenith, $M'M''$ the prime vertical, and N' the point of transit.

Read the *true* altitude upon the primitive at the parallel of altitude passing through N', reckoning from the nearer extremity of AB.

Example.

The method of solution is shown in Figure 4, which represents the diagram.

Required the sun's altitude on the prime vertical and the times of east and west passage in latitude 37° N., when the declination is 17°15′ N. By computation the true altitude is 29°31′; time of west passage 4h. 22m. 40s., east passage 7h. 37m. 20s.

BD is made equal to the declination and BM to the latitude, then DD is the sun's parallel of declination, M the zenith, OM the upper branch of the prime vertical, N the point of transit, $M'E$ the hour circle through N, and BE the measure of the hour angle $BM'E$.

$M'O$ is the revolved position of MO and N' the revolved position of N. $N'L$ is the parallel of altitude through N' and AL is the measure of the true altitude ON'.

To Find the True Bearing or Azimuth of a Heavenly Body.

Article IV. True bearings of heavenly bodies for determining compass error, or the direction of Sumner Lines of Position, may be found from the diagram when either the latitude, declination and hour angle, or the latitude, declination, and altitude are given. The application to Sumner Lines is explained in Article V.

The total compass error is found by comparing the compass bearing of any body with its true bearing at the same time. The deviation of the compass for the direction of the ship's head at the time of observation is found by applying to the total compass error the magnetic variation for the place of observation. The magnetic variation is commonly given by the sailing chart.

Note the Greenwich time of observation. If the latitude and longitude are not known by observation, find them by account. Reduce the declination for the Greenwich time, and correct the altitude when the latter is used.

Hour Angle. For use with the diagram, reckon the hour angle both east and west through 12 hours. The hour angle of the sun west of the meridian is the local apparent time of observation, found by applying the longitude in time, and the equation of time to the Greenwich mean time of observation; the supplement (to 12 hours) of the local apparent time is the hour angle of the sun when east of the meridian.

The hour angle of the moon, or a planet, or a fixed star for the time and place of observation is found by the following formula:

H. A. of body = Sidereal Time of Observation — R. A. of body,
or H. A. of body = R. A. of mean sun + L. M. T. — R. A. of body.

When the angle found by the formula exceeds 12 hours, its difference from 24 hours must be used.

Convert the hours and minutes of the hour angle into degrees and minutes.

Graphical Solution.

Case I.—*When the Latitude, Declination and Hour Angle are known.*

The diagram is first assumed to be a projection of the celestial sphere, composed of hour circles and parallels of declination. M' is the elevated pole, and AB is the equinoctial, or the celestial equator. The primitive is the celestial meridian of the observer.

Figure 5. With the hour angle inspect the scale of AB, and, reckoning from either extremity, find the hour circle of the body.

With the declination inspect the scale of the primitive, and reckoning from either extremity of AB, find the parallel of declination of the body, which must be sought above AB when the declination is of the same name as the latitude, but below when of the contrary name.

Mark the place, N, of the body where its hour circle intersects its parallel of declination.

Reckoning upwards from that extremity of AB which is *opposite* the one from which the hour angle was reckoned, find upon the primitive a point M corresponding to the latitude.

Conceive a sector, $M'OC$, formed by radii to include M' and N. Revolve the sector about O until M' coincides with M, and find N'' the revolved position of N. (Art. I.)

Now assume that the projection is composed of azimuth circles and parallels of altitude. M is the elevated pole, M' the zenith, AB the celestial horizon, and N'' the place of the body.

Upon AB, reckoning from that extremity adjacent to the elevated pole, read the true bearing or azimuth at the azimuth circle passing through N''. Reckon the bearing from north in north latitude and from south in south latitude, and towards the east or west as the body is east or west of the meridian or as the hour angle is reckoned east or west of the meridian.

Expeditious method of finding a series of true bearings of the same body.— When a ship is manœuvred to get a series of compass bearings of a heavenly body, for deviation on the several points of the compass, the time thus occupied will generally be so short that the change in declination during the interval may be disregarded, and the declination as well as the latitude assumed to be constant throughout the series. The true bearings of the body corresponding to all the observations of the series may then be found at one operation upon the diagram.

The graphical solution is effected as follows: Mark the place M as before, then lay a piece of tracing paper upon the diagram, and project upon the former, $N_1N_2N_3$, etc., the intersections of the several hour circles with the parallel of declination of the body. Trace the points O and M'.

Revolve the tracing about O until the traced point M' coincides with M. Read the several true bearings upon AB at the azimuth circles passing through $N_1'N_2'N_3'$, etc., the revolved positions of $N_1N_2N_3$, etc., respectively.

Example under Case I.

The method of solution is shown in Figure 5, which represents the diagram.

In latitude 34° 30′ S., find the true bearing of a body when its declination is 10° north, and its hour angle 3h. 10m. (47° 30′) east of the meridian. The true bearing by computation is south 125° 31′ E. or N. 54° 29′ E.

In Figure 5, AD is made equal to the declination (of the contrary name to the latitude), and AE to the hour angle, then DD is the parallel of declination of the body, $M''E$ the hour circle and $AM''E$ the hour angle. N is the place of the body and $M'OC$ the imaginary sector.

The arc BM being made equal to the latitude, M is the position of the elevated pole after the sector is revolved. MOC' is the revolved position of the sector, N' the revolved position of N, $M'F$ the azimuth circle passing through N', and BF the measure of the azimuth or true bearing $BM'F$.

Graphical Solution.

Case II.—*When the Latitude, Declination and Altitude are known.*

First assume the diagram to be composed of hour circles and parallels of declination, as in Case I.

Figure 6. Mark the point M upon the diagram as before. (In Fig. 6 the assumed data are not the same as in Fig. 5.)

Lay a piece of tracing paper upon the diagram and trace the parallel of declination of the body—or the essential part of it—and the points O and M'.

Revolve the tracing about O until the traced point M' coincides with M.

Now assume that the diagram is composed of azimuth circles and parallels of altitude, as in Case I. M is the elevated pole, and the traced parallel, in its revolved position, is still the parallel of declination of the body.

With the altitude inspect the scale of the primitive, and, reckoning from AB upwards, find the parallel of altitude of the body.

N', the point of intersection of this parallel of altitude and the traced parallel of declination, is the place of the body.

Find the true bearing upon AB at the azimuth circle passing through N'; reckon it from the side adjacent to M, and otherwise as directed in Case I.

Example under Case II.

The method of solution is shown in Figure 6, which represents the diagram.

In latitude 49° 30′ N., find the true bearing of a heavenly body when its altitude is 40° 15′ east of the meridian, and its declination 20° N. The true bearing, by computation, is N. 107° 32′ E. or S. 72° 28′ E.

In Figure 6, AD is made equal to the declination (of the same name as the latitude), then DD is the parallel of declination of the body, which is to be traced. The arc BM being made equal to the latitude, M is the position of the elevated pole after the tracing is revolved about O.

$D'N'D'$ is the revolved position of the traced parallel of declination. AL is made equal to the altitude, then $LN'L$ is the parallel of altitude of the body when M is the pole. N' is the place of the body. $M'F$ is the azimuth circle passing through N' and BF is the measure of the true bearing or azimuth $BM'F$.

Partial Determination of Sumner Lines.

Article V. The Sumner Line of Position is perpendicular to the true bearing, or line of bearing, of the observed body. From this property, if we compute two points in the line of position and project the line upon the sailing chart, we may find from it the true bearing; or if we compute one point in the line and find, by any means, the true bearing or line of bearing of the body for the time and place of observation, we may determine the line of position upon the chart by projecting the point and drawing through it a right line perpendicular to the line of bearing. In the latter case the diagram will give the true bearing with the accuracy required for navigation.

An error of a whole degree in the true bearing — an error greater than is at all likely to occur in using the diagram — produces an error of only one mile in the line of position upon the chart at a distance of sixty miles from the established point, while close to the latter it is practically nothing.

The true bearing may be found as described in Case I or Case II of Article IV, according to the data used.

The line of position may then be projected upon the sailing chart by means of a parallel rule and the compass rose of the chart, or by the following method which will generally give greater accuracy.

By means of a protractor draw somewhere near the established point, a right line making with a parallel of latitude an angle equal to the azimuth or true bearing, and in a direction to be perpendicular to the line of bearing of the body. With the parallel rule draw a parallel to this line through the established point. The second line will be the Sumner Line of Position.

Great-Circle Sailing.

General Remarks.

Article VI. The many conditions necessary to be considered in the selection of an extended ocean route demand for each case a special judgment, but, since in nearly all cases the chief object in view is to shorten the voyage or passage, whatever scheme tends to this end should be weighed according to its merits. It cannot be said that this is commonly done in respect to great-circle sailing.

There are three routes which offer great advantage over the simple rhumb route, and one or another of which may generally be adopted: 1st, the great-circle or direct route; 2d, the meteorological route, often circuitous but passing through regions of favorable winds and currents; 3d, a compound route, made up of a meteorological route embracing stretches upon great circles.

A glance at a globe makes it apparent that the shortest distance between any two places upon the surface of the sphere is upon the great circle which joins them, and that it is only while maintaining her great-circle course that a vessel heads for her port as if it were in sight. Excepting when sailing along a meridian or the equator the course upon a great circle changes continuously with the advance of the vessel, but so slowly that in practice it need be changed, generally, only for each 100 or 200 miles of distance made good. Since the great-circle course for any position of the vessel is quickly found, a necessity for a change of the course is made known. From what has been said, it is seen that a vessel in going over a great-circle route actually sails upon a series of rhumbs closely approximating to a great circle.

It is, unfortunately, too common a practice amongst navigators to accept the straight line of the Mercator chart as a direct route. Apart from magnetic variation, this practice offers a theoretically constant course; but since magnetic variation must be taken into account, and since it is impracticable to long maintain the original

straight line, a constant course is seldom realized excepting for short distances.

The rhumb line of the sphere is a spiral which has the property of making a constant angle with meridians, but upon the Mercator chart it projects as a straight line and thus presents a fallacious appearance of minimum distance. The chart only serves to direct a vessel's course and to mark her progress; the vessel actually sails upon the sphere, and, when her course is shaped by the rhumb, she approaches her port or place upon a spiral.

Every great circle intersects the equator at the extremities of a diameter of the sphere, and is divided at the equator into two equal parts or semicircles. The *vertex* of each semicircle is that point upon it which is highest in latitude. The two vertices are diametrically opposite points of the sphere; they have the same latitude, but of opposite names, and are at 90° difference of longitude from the points where the great circle and the equator intersect. At a vertex the course is east or west. If in approaching a vertex there is northing in the great-circle course there will be southing after passing it, and *vice versa*. In this graphical method no use is made of a vertex excepting when it occurs on the route to be sailed over.

The saving in distance which a great-circle route offers as compared with the corresponding rhumb route varies greatly, of course, amounting sometimes to hundreds of miles. Between Yokohama, Japan, and Cape Flattery, Washington Territory, the example given herewith, it is 268 miles. A comparison may be made for any two places by subtracting the distance found upon the diagram from the rhumb distance computed by the rule of Mercator's sailing.

A knowledge of the great-circle course is of importance in working to windward, for in blindly following the rhumb the vessel may even be sailed away from her place of destination. The great-circle course frequently varies three or four points from the rhumb course. On the route from Yokohama (Cape King) to Cape Flattery, the great circle course at Cape King is NE., while the rhumb course is E. by N., a difference of three points. In this case, for a wind directly ahead on the rhumb an uninformed commander would lay his vessel on either tack indifferently; if on the port tack, and the vessel work in twelve points, she would head SE. by S., nine points away from her great-circle course, the only course on which she would head directly for her place of destination. On the starboard tack she would head N. by E., only three points away from her great-circle

course. It is quite certain that this vessel would be laid on the unfavorable tack for a wind whose direction was between the great circle and the rhumb courses. Less extreme cases may be assumed and the possibilities investigated by any seaman. It does not suffice to say that the great-circle course is to the northward of the rhumb in north latitude and to the southward in south latitude; in order to know when to go about and make the very best of his way to windward a commander should know the amount of variation of the two courses.

When a great-circle route has been decided upon, the whole route should be projected upon the sailing chart, either by a continuous line, or by frequent points, that it may be subjected to examination for general direction, obstructions, meteorological conditions, etc. When the vessels falls off the original great circle it is not attempted to regain it, for the shortest distance then is upon the great circle which joins her actual position and her place of destination. Her course is always the great-circle course at her actual position, and this may be found from the diagram, or the general direction of the original projected great circle may be followed by shaping rhumb courses by the Mercator Chart; the former method is preferable because more exact.

Graphical Solutions.

Let M be the place of departure, and N the place of destination.

To find the great-circle course. First assume the diagram to be a projection of the terrestrial sphere, composed of parallels of latitude and meridians of longitude. M' is the North Pole, M'' the South Pole and AB the Equator. The primitive is always the meridian of the place of departure.

Figure 1. Project M upon the *primitive* in its proper latitude—north or south as the case may be—on the right side if it is the eastern place, on the left side if it is the western place.

Project N in its proper latitude, and upon a meridian whose difference of longitude from M is that of the two places.

Conceive a sector, MOC, formed by radii, to include M and N (Article I). Note, by a glance simply, if N would fall above or below AB, if the sector were revolved so as to make M coincide with that extremity of AB which is adjacent to M. If above, reckon the course from north; if below, from south.

Revolve the sector about O until M coincides with M' or M''—the *nearer* extremity of $M'M''$—and find N' the revolved position of N.

Now assume M' or M''—whichever is the revolved position of M—to be the place of departure and N' the place of destination. The former meridians then become great circles through the place of departure, and the parallels are parallels of great-circle distance from the same place. The scale of AB gives the angle which each great circle makes with the primitive, the meridian of the place of departure, and hence the course.

The great circle passing through M', N' and M'' is the required great circle: read the course at its intersection with AB, reckoning from the nearer extremity of AB. Having the course, reckon it from north or south as previously found, and towards the east or the west as the place of destination is to the eastward or westward.

To find the great-circle distance. Find the great-circle distance upon the primitive at the parallel of distance passing through N', reckoning it from M' or M''—the place of departure—by taking the complement of the reading. Multiply the degrees by sixty and add the minutes; the result will be the distance in nautical miles.

To find the vertex and other points upon the great circle. The quickest method is by means of tracing paper. Trace the required great circle through N', and revolve the tracing about O until M' or M''—whichever is the revolved position of M—coincides with M. The traced great circle will then pass through M and N.

If the vertex is of any use it falls upon the diagram, and it is found upon a meridian at 90° difference of longitude from the point where the traced and revolved great circle intersects AB, the equator.

Take points upon the revolved great circle at 5° or 10° intervals of longitude from M towards N—or, if desired, on both sides of the vertex when it falls between M and N—and find the latitude and longitude of each, measuring latitudes upon the primitive and *differences of longitude from* M upon the scale of AB. Transfer the points to the sailing chart and adjust or "fair" a curve to them.

The more exact method is to take the intervals from M towards N, for the points will then fall upon printed meridians of the diagram. The advantage of measuring from the vertex is that points equally distant in longitude on either side have the same latitude.

NOTE.—The vertex and other points may also be found without tracing paper, as follows, taking the case projected in Figure 1.

The Vertex. Figure 7. Observe which semi-diameter, OA or OB, bisects the required great circle $M'N'M''$, and conceive it to be revolved in the

direction in which the sector *MOC* (of Fig. 1) was revolved, and through an equal angle at *O*. The revolved semi-diameter being the semi-equator when the place of departure is at *M'* (or *M''*), find its intersection, *E*, with the required great circle. The vertex, *V*, of the latter is upon a parallel at 90° from the parallel of *E*, reckoning in the opposite direction to that in which the semi-diameter was revolved. When the rule fails the vertex is not upon the diagram and is of no use.

Conceive a radius, *OR*, through *V*. Revolve the sector *M'OR* (or *M''OR*, as *M'* or *M''* is the place of departure) about *O* until *M'* (or *M''*) coincides with *M*. Then *V'*, the revolved position of *V*, will be the vertex of the required great circle through *M*.

Other points. Figure 8. Mark the points *X*, *Y*, *Z*, etc., in which the required great circle, *M'N'M''*, is intersected by parallels of distance at intervals of 5° or 10° from the revolved place of departure at *M'* or *M''*.

Conceive radii, *OR*, *OS*, *OT*, etc., through the points *X*, *Y*, *Z*, etc., respectively, and when the sector *M'OC'* (or *M''OC'*) of Fig. 1 is revolved back to *MOC*, revolve these radii severally in the same direction and through an equal angle at *O*. Find the revolved positions, *X'*, *Y'*, *Z'*, etc., of the points *X*, *Y*, *Z*, etc. The revolved points will be points upon the required great circle through *M*; upon the sphere they will be separated by equal distances.

EXAMPLE.

In this example the results are obtained by computation that they may be compared with those obtained from the diagram. This particular great circle is not practicable because it passes north of the Aleutian Group. It is introduced that it may be compared with a composite route between the same places, given in Article VII. Figure 1 represents the diagram and contains the projection of the unbroken route.

Great circle from *M*, a position in latitude 34° 50′ N., longitude 140° 00′ E., near Yokohama, Japan, to *N*, a position in latitude 48° 30′ N., longitude 125° 00′ W., near Cape Flattery, Washington Territory.

Position of the Vertex, latitude 54° 08′ N., longitude 160° 12′ W.
First great-circle course, *N.* 45° 32′ E., true.
Constant rhumb course, *N.* 79° E., "

Distance on great circle,	4058	miles.
Distance on rhumb,	4326	"
Difference of distances,	268	"

Points upon the Great Circle.

Long. from Vertex.	Latitudes.	Longitudes.	Longitudes.
5°	54° 02′ N	165° 12′ W	155° 12′ W
10°	53° 43′ "	170° 12′ "	150° 12′ "
15°	53° 11′ "	175° 12′ "	145° 12′ "
20°	52° 26′ "	179° 48′ E	140° 12′ "
25°	51° 25′ "	174° 48′ "	135° 12′ "
30°	50° 09′ "	169° 48′ "	130° 12′ "
35°	48° 34′ "	164° 48′ "	
40°	46° 40′ "	159° 48′ "	
45°	44° 22′ "	154° 48′ "	
50°	41° 39′ "	149° 48′ "	
55°	38° 26′ "	144° 48′ "	

In Figure 1, AM is the latitude of M, and BL, or HN, the latitude of N. AH measures the difference of longitude of M and N. MOC is the sector.

$M'OC'$ is the revolved position of the sector, N' the revolved position of N, and $M'N'M''$ the required great circle. The arc $M'D$ measures the great-circle distance $M'N'$, and BG measures the course $BM'G$.

MVE is the revolved or true position of the required great circle, E the point where it intersects the equator, EI the measure of 90° of longitude from E, IVM' the meridian of the vertex, V the vertex, AK, or IV, the latitude of the vertex, and AI measures the difference of longitude of M and V.

Composite Great-Circle Sailing.

General Remarks.

Article VII. When the great circle joining two places ascends into higher latitudes than it is prudent or possible to penetrate, a modified or composite great-circle route may be taken between them. Having determined the highest latitude to which he will sail, the navigator composes his route of an arc of the limiting parallel of latitude, and parts of two great circles whose vertices lie upon this parallel, one great circle passing through his place of departure and the other through his place of destination. He then sails upon the first component great circle until its vertex is reached, thence along the limiting parallel to the vertex of the second component great circle, and finally upon the second great circle to his place of destination. This composite route is the shortest possible under the

restriction of limited latitude. Along the limiting parallel of latitude the course is shaped upon the Mercator chart by the common method of rhumb sailing.

NOTE.—For an example of a composite great-circle route, projected stereographically, see under Professional Notes, "*A Fallacy in Composite Great-Circle Sailing.*"

To find the Vertex, V_1, and other points upon the first component great circle. Let M be the place of departure and N the place of destination.

Figure 2. Project M upon the primitive in its proper latitude as in Article VI.

Lay a piece of tracing paper upon the diagram and trace the limiting parallel of latitude (or a small part of it about where it is judged the vertex will fall), and the points O and M. Revolve the tracing about O until M coincides with M' or M''—whichever is the nearer.

The first component great circle is that which is tangent to the traced parallel in its revolved position. Read the first course upon AB at the tangent great circle. Trace this great circle and revolve the tracing about O until M comes back to its original position.

Obtain points for transfer to the sailing chart as described in Art. VI, and find the vertex, V_1, upon the limiting parallel at 90° from the point where the traced and revolved great circle intersects AB.

To find any course and distance upon the first component great circle. Having found the vertex V_1, treat it as a place of destination, or as N, for finding all courses and distances upon the first component great circle, following the method of Article VI.

To find the vertex V_2, and other points upon the second component great circle. Proceed by the rule prescribed for the first component great circle, but as if sailing *from* the place of destination towards the limiting parallel. That is, treat the place of destination as M; project it upon the primitive on its own side and in its proper latitude; trace the limiting parallel; revolve the tracing about O, and find the tangent great circle as before.

To find the course and distance upon the second component great circle. Treat the place of the ship as M and the place of destination as N. Then proceed as prescribed in Article VI.

To find the distance upon the limiting parallel. Proceed by the rules for parallel sailing as given in books on practical navigation, or

inspect the table on page 268 of Bowditch, new edition, or page 64, old edition.

EXAMPLE.

In the case given in the example under Article VI, assume 51° north as the limiting latitude, and find the composite route between the two places. The following results are obtained by computation.

Figure 2 represents the diagram, and contains the projection of the first component great circle.

Vertex V_1, latitude 51° N., longitude 164° 18′ W. First course, *N.* 50° 04′ E.

Vertex V_2, latitude 51° N., longitude 148° 45′ W.

Distance from M to V_1,	2562 miles.
Distance from V_2 to N,	929
Distance from V_1 to V_2 on the parallel of 51° N. by parallel sailing)	587
Total distance by composite route,	4078
Total distance by rhumb,	4326
Difference,	248

Rhumb course *N.* 79° E.

In Figure 2, AM is the latitude of M, AK the limiting latitude, and KK the limiting parallel. M''' is the revolved position of M' when M is revolved to M', and $K'K'$ is the revolved position of the traced parallel KK. $M'GM''$ is the first component great circle tangent to $K'K'$, and BG measures the first course $BM'G$.

MV_1E is the traced and revolved great circle when M arrives back at its original position, E the point where it intersects the equator, IE the measure of 90° of longitude from E, $M'I$ the meridian of V_1 the vertex, and AI the measure of the difference of longitude of M and V_1.

Having found V_1, the tracing is again revolved about O until M arrives at M', then V_1' is the revolved position of V_1, and $M'D$ the measure of the distance of V_1 from M.

APPENDIX.

SIMPLE ORTHOGRAPHIC CONSTRUCTION FOR STAR IDENTIFICATION.

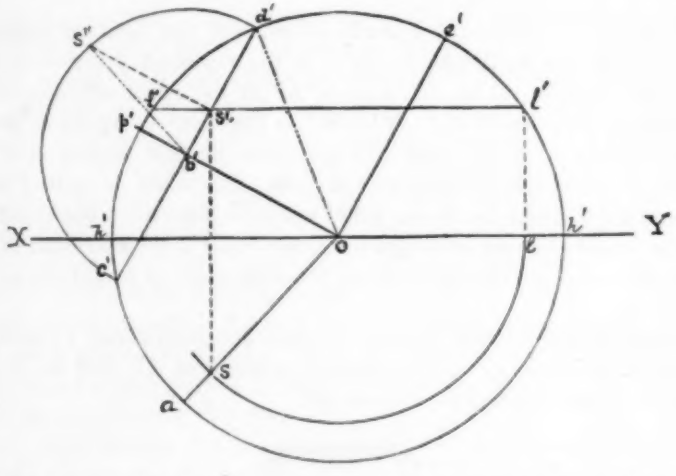
When the stereographic projection, or diagram, is not at hand, the simple special construction shown in the accompanying figure

may be used for star identification, when the data prescribed in Article II is given. The construction will be greatly facilitated by the use of draftsman's triangles.

Describe any circle, $h'd'h'a$, about o as a centre, and draw a diameter $h'h'$. Make the arc $h'p'$ equal to the latitude, $h'l'$ equal to the altitude, and $h'c'a$ equal to the azimuth. Draw the radii oa, op' and oe', making oe' perpendicular to op'. Draw $l'l'$ parallel and $l'l$ perpendicular to $h'h'$. With centre o and radius ol describe the arc ls, cutting oa in s. Draw ss' perpendicular to $h'h'$ and cutting $l'l'$ in s'.

Through s' draw $c'd'$ perpendicular to op', cutting op' in b' and the original circle in c' and d'. With center b' and radius $b'd'$ describe a semicircle $d's''c'$. Draw $s's''$ perpendicular to $c'b'd'$, cutting the semicircle in s''.

The angle $s''b'd'$ is equal to the hour angle of the star east or west of the meridan, as the case may be. The angle $d'oe'$ is equal to the declination of the star. When d' falls on the same side of e' as p', the declination is of the same name as the latitude; when it falls on the opposite side of e', the declination is of the opposite name to the latitude. Having the declination and hour angle, find the star's right ascension as directed in Article II.



Explanation of the Figure. The figure is a projection of one-half of the visible celestial sphere, $h'd'h'$ on the plane of the observer's meridian, and $h'ah'$ on the plane of his horizon. On the vertical

plane $h'd'h'$ is the upper meridian, $h'h'$ the horizon, $l'l'$ the parallel of altitude of the star, p' the elevated pole, op' the semi-axis (or the upper branch of the 6 o'clock hour circle), oe' the semi-equinoctial, s' the place of the star, $c'd'$ the parallel of declination of the star, and d' the point of transit over the upper meridian. The semicircle $c's''d'$ is the parallel of declination, revolved about its diameter $c'd'$ into the vertical plane, and s'' is the revolved position of s'. In the horizontal projection $h'ah'$ is the horizon, oa the azimuth circle, and ls the parallel of altitude of the star. s is the place of the star. This same construction may be used for other problems.

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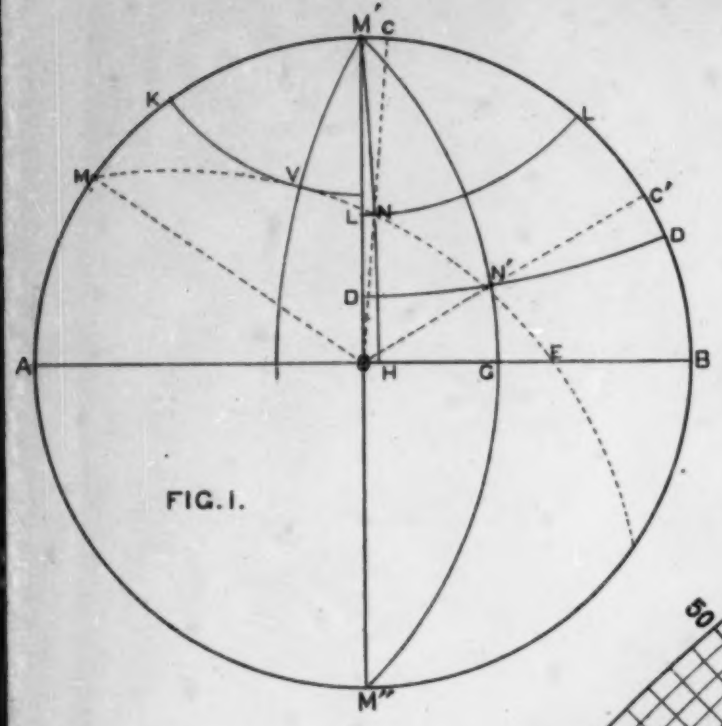
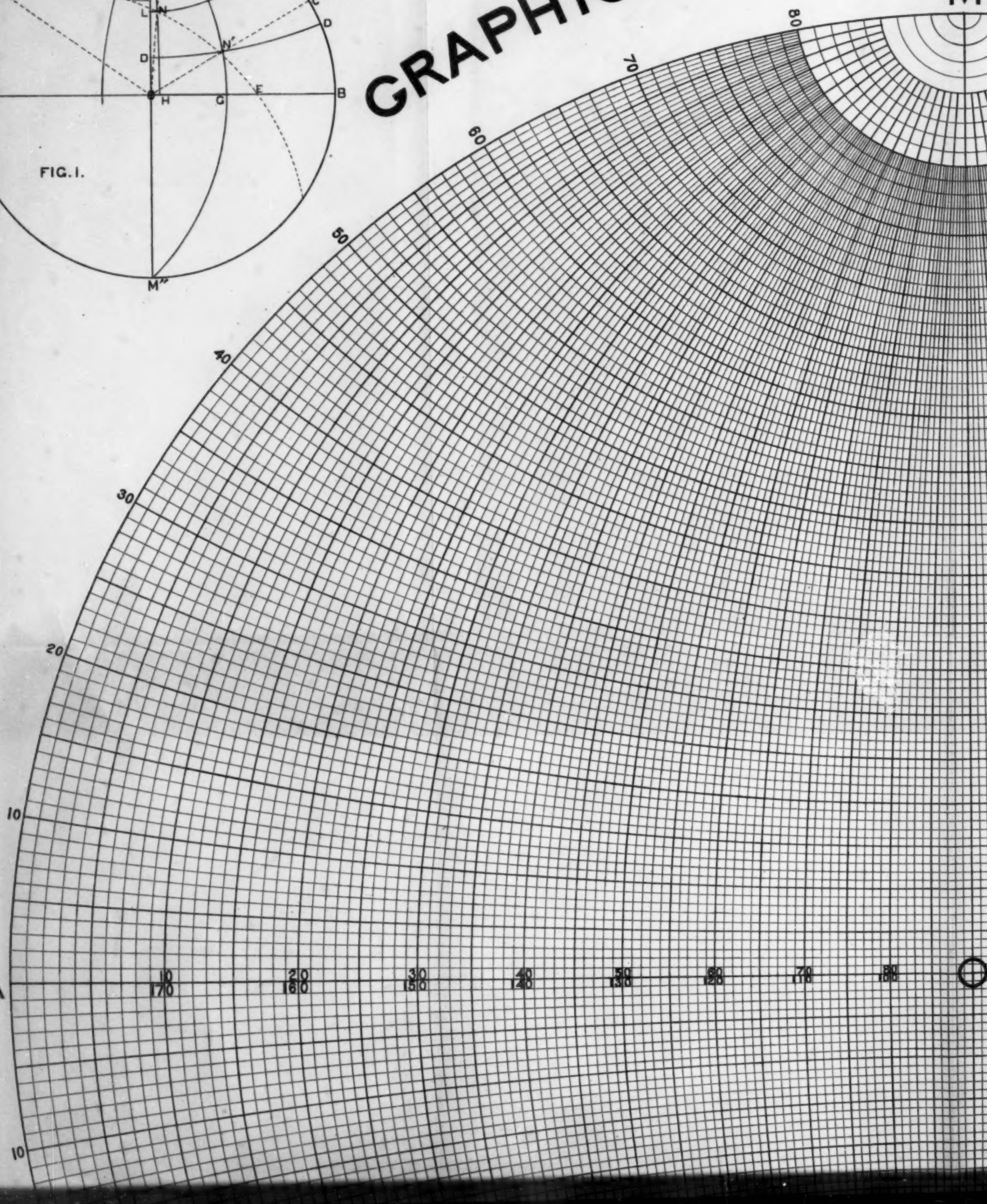


FIG. 1.

GRAPHICAL METHOD

M



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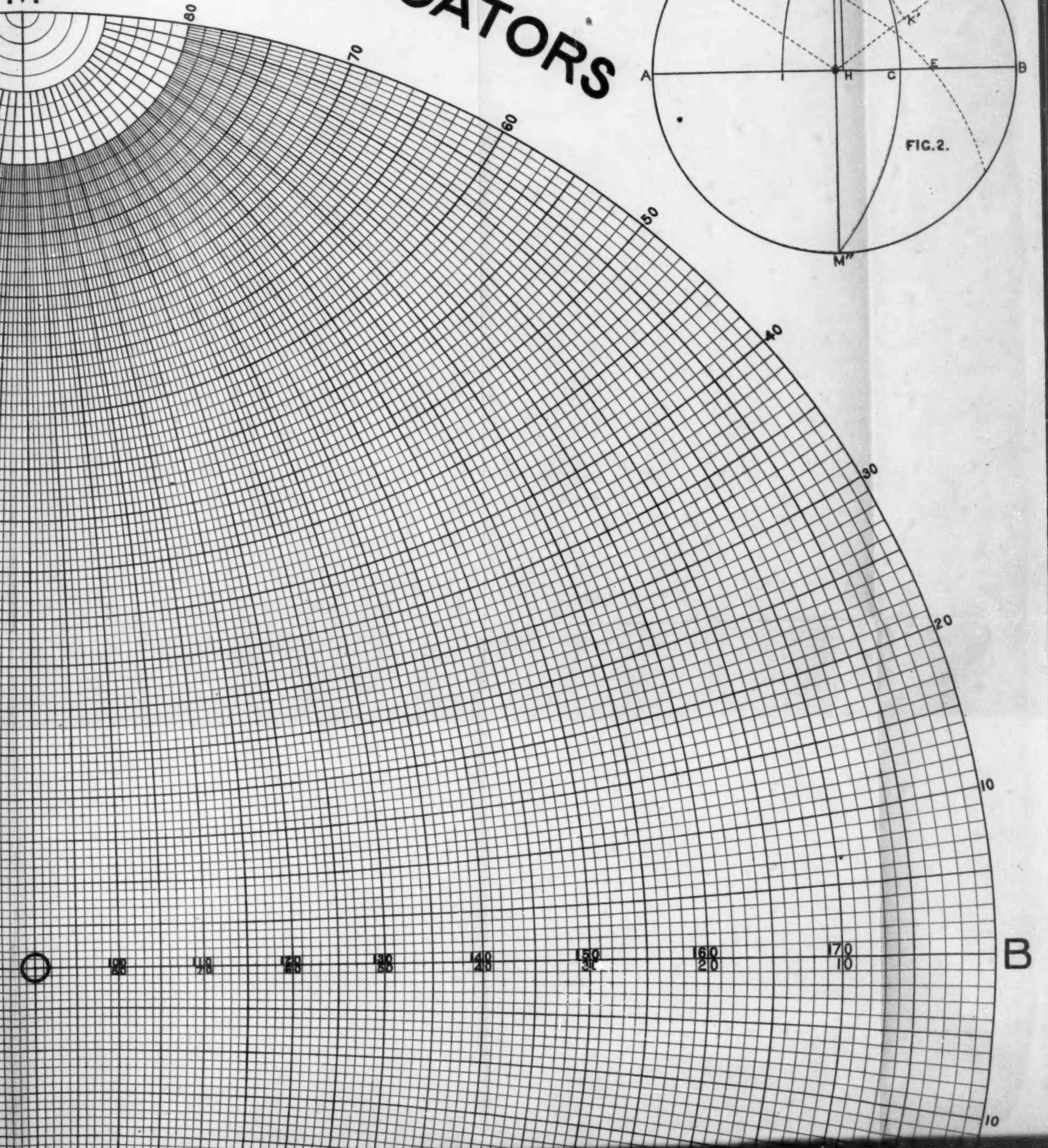
M′



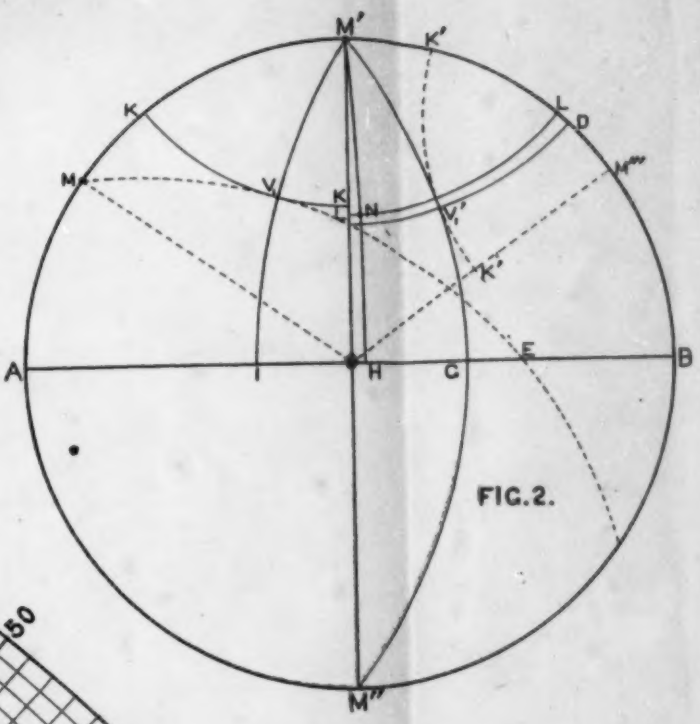


FIG. 2.

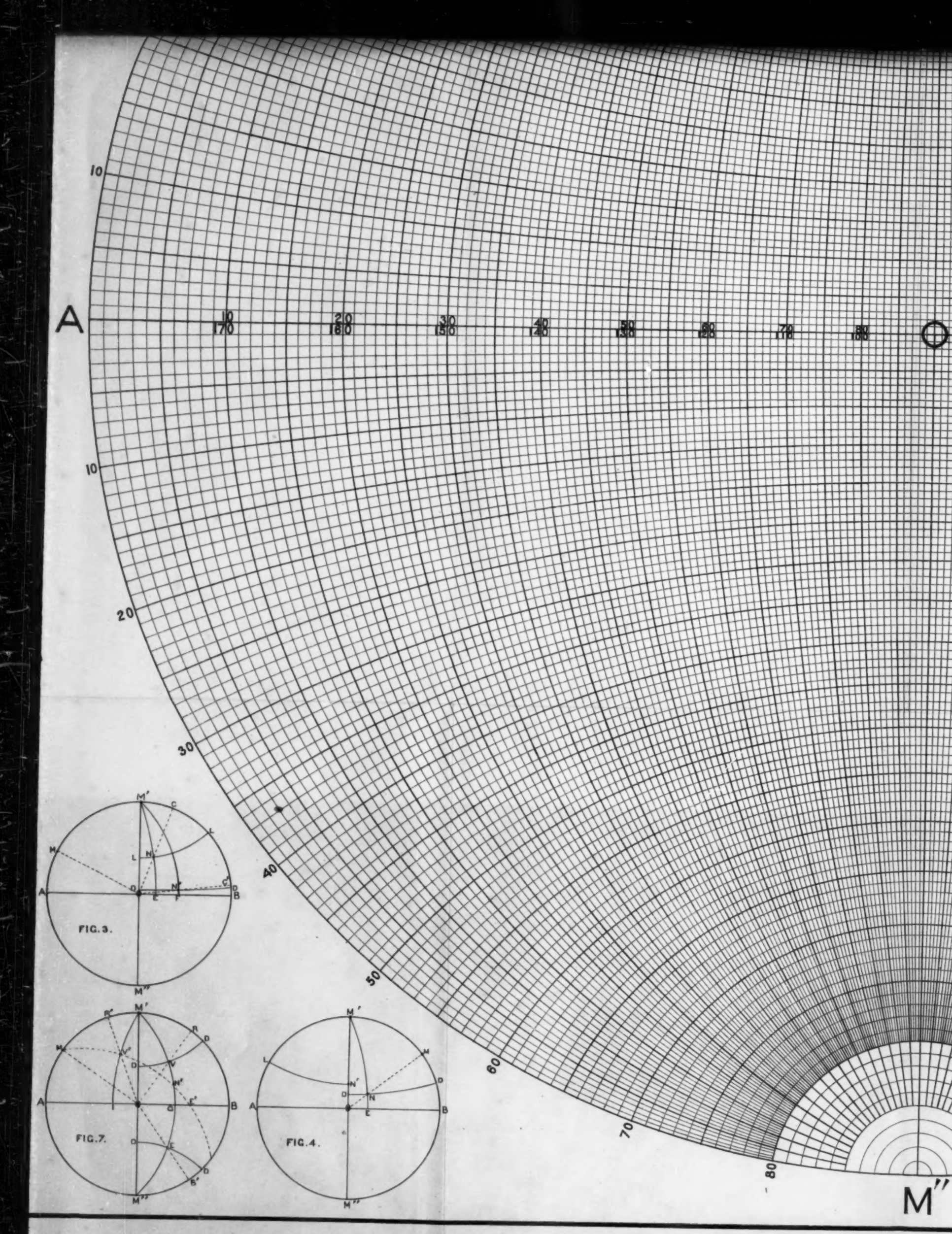


FIG. 3.

FIG. 7.

FIG. 4.

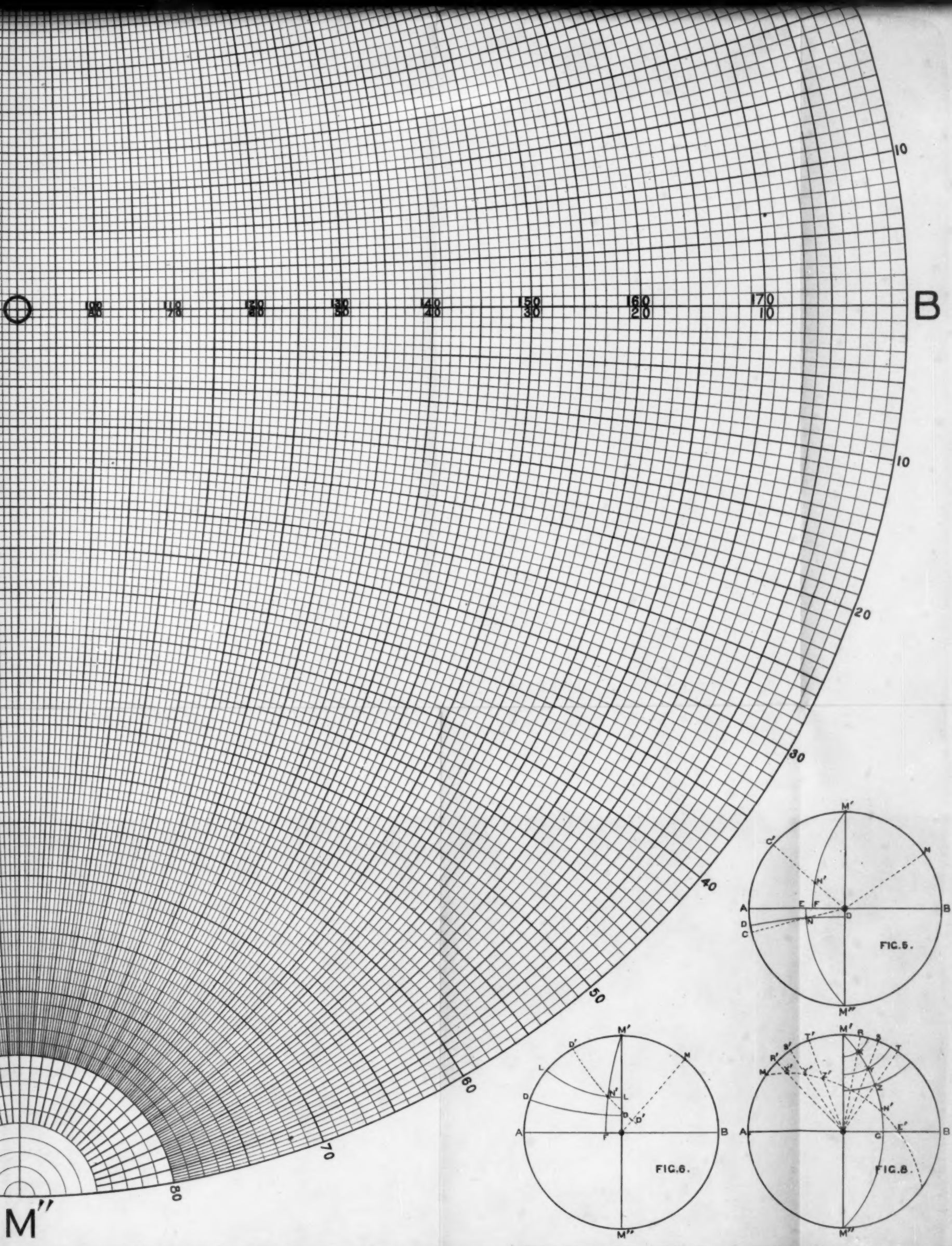


FIG. 5.

FIG. 6.

FIG. 8.

NAVAL INSTITUTE, ANNAPOLIS, MD.

THE TURNING CIRCLE: APPLICATION OF COAST-SURVEY METHODS TO THE DETERMINATION OF.

By Lieutenant A. McCrackin, U. S. N.

The following well-known methods for determining positions are proposed for use in the turning trials of steamers, viz:

Positions determined:

1. By theodolite angles taken by two observers on shore occupying known signal points.

2. By one theodolite angle from the shore and one from the steamer.

3. By two angles from the steamer on three known shore signals (three-point problem).

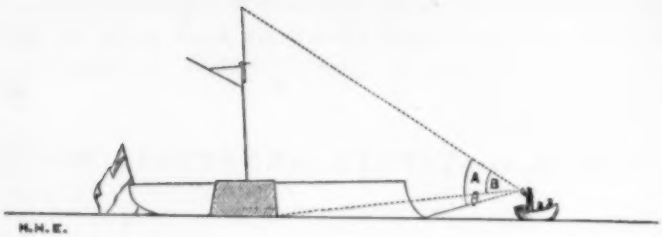
The approximate methods described by W. H. White—*Navy Scientific Papers, No.* 7—are not adequate to our needs; and the method given in General Order No. 314 is not simple, nor applicable to all classes of steamers. The latter method requires outside of the engine-room, two chip observers, two plane-table observers, one compass observer with recorder, and one boat observer with recorder; or eight (8) observers and six (6) watches—so that the chances for personal and time errors are very great, in addition to the difficulty of taking simultaneous observations and consequent trouble in plotting the data.

There are other objections to the required method, which do not arise in those proposed, viz:

1. There are two causes of error in the angle which the boat-observer takes between the steamer's mast-head and water-line:

a. The difference between the observed angles when the steamer is broadside and end-on.

Error, $\theta = A - B$.



b. The difference in height of mast-head due to the heeling of the steamer while turning.

These two errors will, however, be small. Furthermore, unless the boat is moored, neither the bearings and angles taken from it, nor the plane-table angles taken from the steamer, on the boat, are of much value.

In the trials of the Alarm, and the monitors Passaic and Nantucket, the "mast-head" angles were often very small and practically useless.

2. The plane-table angles from the bow and stern are not reliable, on account of the impossibilty of keeping the tables level while the steamer heels in turning.

3. The difficulty in obtaining the true speed from the chip observations; as, in quick-turning steamers especially, it makes a great difference in the apparent speed, on account of the drift, whether the chips are thrown on the side of the steamer which is nearer the centre of the circle, or on the outer side.

4. The compass observations are not accurate, as the compass-card will not travel so fast as the steamer turns; and especially is this true in quick-turning iron steamers like the monitors. Moreover, in iron steamers it is very difficult to obtain the proper deviation to apply to the compass-readings, when the steamer's angular motion is so rapid. It is also difficult to get an object so far distant that there shall be no parallax during the turning trial.

The three proposed methods reduce the number of observers and watches, thus decreasing the personal and time errors, they all eliminate the compass, and they are applicable to all sizes and classes of steamers.

The direction of the steamer's keel is obtained by an observer on board, who takes the angle with a sextant, between a fore-and-aft line and one of the shore signals.

The position of the steamer and the direction of her keel being plotted, and the times being known, we have given all the data necessary for determining her speed, drift-angle, and properties of the turning circle.

If the trial is made during slack water, no correction for current will be necessary; but, if required, an observer in a boat anchored near the place of trial can measure the current. The position of the boat may be determined by the same method used in the case of the steamer. The direction of the current is determined by the boat-observer taking the angle between the log-chip and one of the shore signals; and the strength of a weak current can be measured more accurately by using cod-line and a cone-shaped canvas bag, than by the ordinary line and chip.

Evidently, the third method (three-point problem) is the best one, for the following reasons, viz:

1. The sextant is the only instrument required in taking the observations.

2. The three observers and the recorder may all be stationed together, thus insuring the accurate location of the steamer and the direction of her keel at the *same* instant.

3. The data is ready for plotting as soon as it is recorded, and does not require any comparison or preparation, as in the other methods.

4. The positions are so easily and rapidly plotted with the three-armed protractor.

In determining the Tactical Diameter of the monitor Nantucket, this past summer, the following methods were used:

1. The method required by General Order No. 314, which, on acccount of the small values of the mast-head angles, and difficulty of obtaining the speed and drift-angle, was found to be inapplicable. At the same time of using this method, positions were determined.

2. By angles taken by two observers occupying known shore stations. These observers used ship-compasses and azimuth-circles mounted on tripods. The angles gave the position of the steamer; but the work was not all plotted, on account of the inaccuracy of the plane-table observations for determining the drift-angle.

3. The three-point method, of which the commanding officer of the Nantucket said, he had no hesitation in saying that he considered it by far the best method he had seen tried.

The place selected for this trial was in Gardiner's Bay, L. I.

Only three signals were found necessary, Gardiner's Point Light

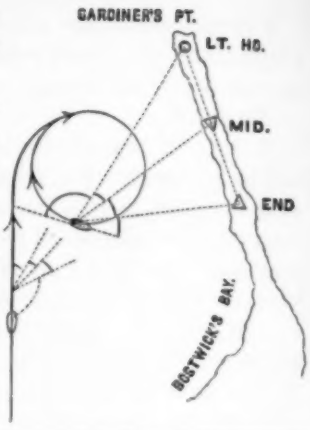
House being used as one; they were 3000 feet apart, and in a straight line.

The distance between the signals was measured with a patent-log line, 200 feet long; using a spring balance to secure an equal strain on the line when making the measurements.

The base line was measured, and the two signals erected in one afternoon.

The signals were made out of drift-wood found on the beach.

The following form was used in recording the observations:



No.	Time.	Angle between		Angle between			Remarks.
		End and Mid.	Mid. and Light.	Signal.	Bow or Stern.	Angle.	

The observers stood together on the hurricane deck; and it was found that observations could easily be taken and recorded every 30 seconds.

The keel observer stood amidships, and for a fore-and-aft line used the flagstaff and stancheons.

In plotting the work, tracing paper was used, which made the task more tedious than where a metal three-armed protractor is used. The scale used was $\frac{1}{2500}$.

The three-point method can be used any place where there is a base-line; but it is suggested that, as the measured mile is in Narragansett Bay, the position of shore signals could be there determined from the Coast-Survey triangulation points, and permanent monuments erected. Charts, on a convenient scale, could be furnished from the department, with the signals plotted thereon; and metal three-armed protractors could be kept at the station on Coaster's Harbor Island, for the convenience of those steamers which are not supplied with them.

NAVAL INSTITUTE, ANNAPOLIS, MD.

A NEW METHOD OF MAKING RUNNING SURVEYS.

By Ensign John H. Fillmore, U. S. N.

A method of sketching in shore-lines when making running surveys or reconnoissances which avoids the necessity of estimating distances, or depending on the eye to get the configuration of the shore-line, or taking bearings with the compass.

The instrument used is a modification of the ordinary plane table, and consists of a plane table or drawing board, mounted on a tripod, and two rulers. One ruler is attached to the edge of the board so as to move freely in the direction of its length across the board, with room underneath it for a sheet of sketching paper. This ruler is pointed at one end, and graduated on one edge from the pointed end as zero. The other is an ordinary straight-edge ruler with sight vanes at the ends, and is not attached to the board in any way. (See Figures 1 and 2, Plate I.)

To sketch in a shore-line, the ship or boat runs along the shore at as uniform a speed as possible, and with as few courses as is consistent with keeping at a convenient distance from the shore; the distance from the shore being determined by the minuteness of the details which it is desired to see and record. The board is mounted on deck so as to command as much of the horizon as possible, and is so placed that the pointed ruler is parallel to the ship's track; ordinarily this will be parallel to the ship's keel. When the ship is making drift or steering a range the ruler is to be parallel to the course actually made; how it can be so placed will be explained hereafter. A line drawn along the edge of this ruler will be the ship's track on the paper. The graduations on this ruler represent time, so that if at any instant its point is at the ship's position on the paper, then at any other time, say three minutes later, the point may be moved forward to the ship's new position by moving it forward three minutes or

three divisions of its graduation. Thus at any instant when the ship is moving along the shore the point of this ruler may be put at her proper position on the paper at that instant; the draughtsman having a watch before him for that purpose. Now to put in the shore-line, bearings are taken of prominent points of the shore with the sighting ruler, having its edge against the point of the time ruler,—the latter being at the proper time or place in the ship's track,—and these bearings are drawn on the paper. As soon as more than one bearing is taken of the same point on shore from different places or times in the ship's track, that point is fixed on the paper by the intersection. It is, in fact, fixed by a triangulation on the point with the ship's track as a base line. (See Plate II.) It is not necessary, of course, to wait for even minutes or divisions of the ruler graduations, but at any instant when a bearing is wanted, the draughtsman, noting the time by the watch, can move the time ruler forward to the proper position, by estimating the fractions of minutes between the divisions. By selecting points as they come in sight on the bow, taking bearings then, again when nearly abeam, and again when on the quarter, good angles can always be made. The whole shore-line is thus put in by cuts on the prominent or necessary points, the draughtsman filling in the shore-line between these points as the ship passes along it. Any number of intersections may, of course, be drawn through the same point to verify the intersections; and many points may be kept in hand at the same time by slight pencil notes on the different lines drawn to keep them from becoming confused. Any prominent peaks or landmarks beyond the shore-line, or in fact anything in sight from the ship in any direction, may be plotted very accurately on the paper by taking bearings of them from time to time as the ship moves along. (See Plate II.)

When the ship's course is changed, turn the paper, underneath the time ruler, through the angle of change about the point of the time ruler occupying the ship's position on the paper at the time of turning, turning the paper to the right when the course is changed to the left, and *vice versa;* the edge of the time ruler will then be along the ship's new track. This angle of change may be laid off with a protractor; or if the ship is to head for a visible point, the new track may be drawn with the sighting ruler, the same as any other bearing, just before turning, and the paper then turned until the edge of the time ruler is along the new track.

The sketch is connected with known points and plotted in the

following manner. The ship is carefully logged,—preferably by frequent readings of the patent log or a careful record of the revolutions of the engine,—and a record kept of the courses and distances, times of changing courses, &c. A time record is also kept on the sketch itself by putting the time down frequently along the ship's track; the separate record of the officer of the deck or other person than the draughtsman being used when finally plotting the work. When the sketch is from one known point to another, these points may be cut in the same as the other points of the shore-line; or the ship's starting and finishing points may be determined by sextant angles on known points or signals. To plot the work, the ship's track is laid down from one known point towards the other, and the second point is plotted from the sketch the same as the other points of the shore-line. Then, all known errors having been eliminated, the difference between the plotted position of this known point and its true position is an error which must be distributed throughout the ship's track. This may be done as shown in the figure. (See Figure 3, Plate III.) The full line represents the plotted track of the ship and the broken line the corrected track. The dotted lines are drawn through the points where the course was changed and parallel to the line through the plotted and true positions of the second known point. And the lines *Bc*, *cc*, &c. are of such lengths that *Bb* is to *AB* as *Dd* is to *ABCD*, and that *Cc* is to *ABC* as *Dd* is to *ABCD*, &c. And *Dd* is equal to *Ee*. The error is thus distributed proportionately throughout the whole track.

When there is only one known point, a run may be made along the shore-line as far as required and back to the same point, then plotting the whole course; the error in the final plotted position of the known point can be distributed in the same manner.

An examination of this method of making a running survey will render it evident that when running between known points, every error except unrecorded variations in the speed, unknown variations of currents, and unknown irregular errors of the compass, are eliminated; and these are errors necessarily occurring in every running survey not a triangulating one. As before suggested, it avoids all necessity of estimating or guessing distances with the eye, or of depending on the eye for the configuration of the shore-line. It has been found in practice that many irregularities, such as bights and bays in the shore-line which are unperceived by the eye, will be recorded by this method. Such sketching has been done heretofore, when making

running surveys, by the clumsy and inaccurate methods of bow and beam bearings and compass bearings and off-hand sketching. The far greater number and more accurate bearings taken by this method add much to the accuracy of the shore-line obtained. Its rapid and easy use, its self-plotting, and its plotting while the shore-line itself is before the draughtsman, make it especially adapted to places where the shore-line is intricate, as where there are many islands and rocks and many breaks in the shore-line,—a few tangents to an island, from different points in the ship's track, completely defining it.

Various ways of adding to the efficiency of the method will suggest themselves to any one using it. For instance, if the steering is bad or difficult, the draughtsman can, by noting the bearing of some object ahead, know when the ship is exactly on her course, and by only taking bearings then, make the method nearly independent of bad steering. When this precaution is taken, if the bearings of points do not intersect well, then the time ruler is not parallel to the ship's actual course. This should be corrected by turning the board until the time ruler is parallel to the actual course. When the *change* of drift is equivalent to a change of course, then the paper should also be turned a corresponding amount in the opposite direction, the same as for any other change of course. It will be found that the instrument itself will render drift apparent which is hardly discernible in any other way, for when the time ruler is parallel to the true course the intersections will be remarkably close (see Figure 4, Plate III), and any deviation, especially if it repeat itself in successive points plotted, is good evidence of drift, and the amount by which a quarter-bearing fails to pass through the intersection of the bow and beam bearings shows how much the drift is and how much the board is to be turned to correct for it. Figure 4 is an exact copy of the intersections of a number of bearings taken of a point on shore from a ship going about six knots an hour and about two miles off the point; no precautions being taken to favor the method,—the quartermaster at the time was steering an ordinary course, not knowing that anything depended on his steering, and the bearings were taken haphazard as the ship went by the point, as a test of the method.

This method of making a running survey was devised and used on board the U. S. C. S. Hassler in the summer of 1883. Although the instrument there used was made on board ship, it was found to work exceedingly well; many miles of surveying were done with it, both in steam launches and in the ship itself. It was used for putting

Fig.2

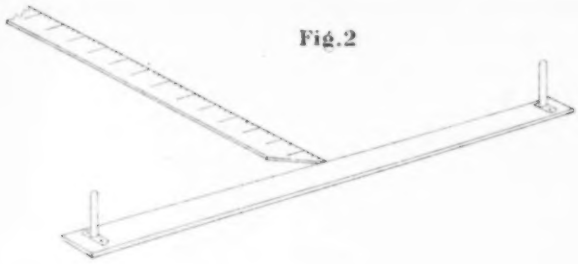


Fig.1

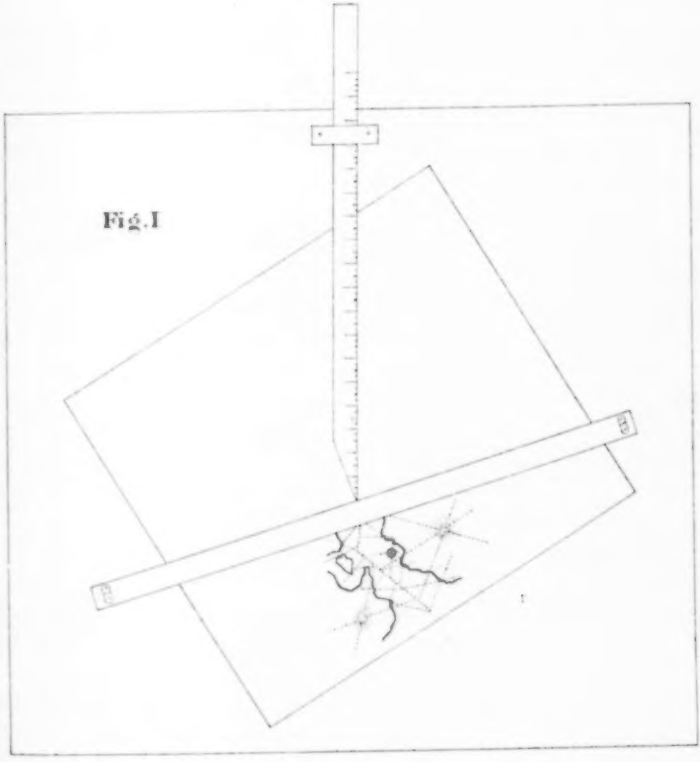
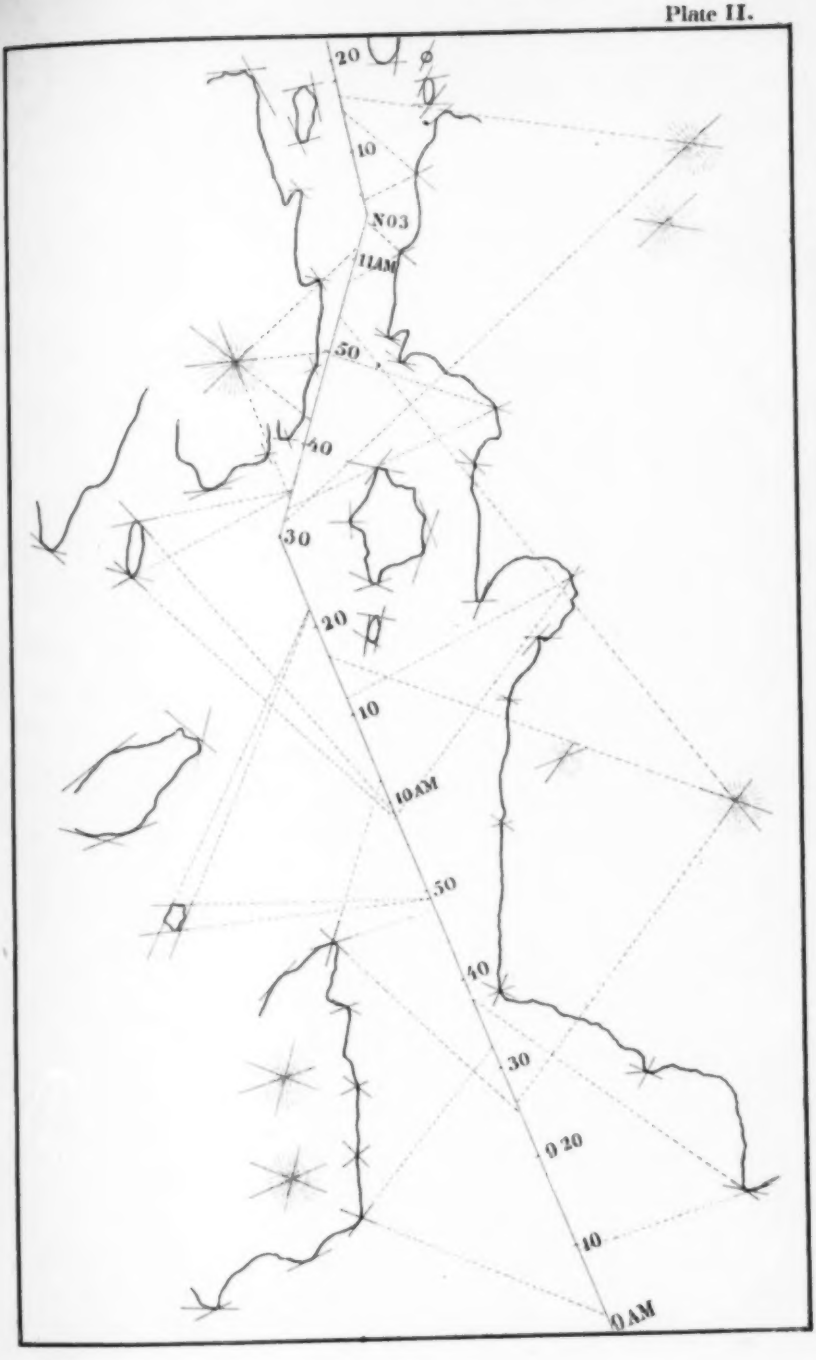


Plate II.



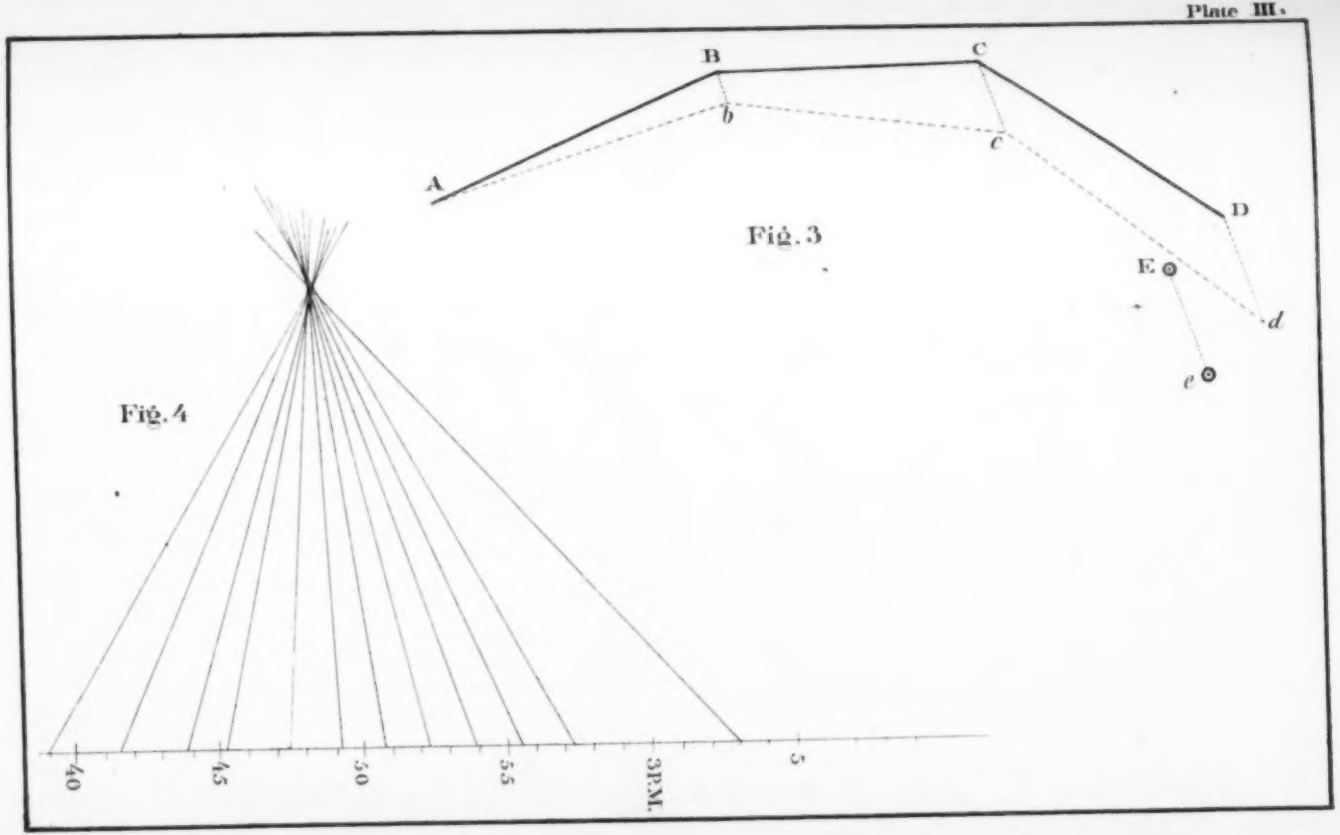


Fig. 3

Fig. 4

in the shore-lines between signals when they were far apart, and also for reconnaissance work independent of known points.

An interesting mathematical problem will be found in determining the curve of the intersections of many bearings taken of the same point when the time ruler is not parallel to the true course.

A modification of the same instrument can be used in navigating known waters, entering harbors or running along the shore, determining at any instant the ship's exact position, or tracing on the chart her exact course along a shore, through a channel or into a harbor.

U. S. Hydrographic Office,
February 9, 1885.

NAVAL INSTITUTE, ANNAPOLIS, MD.

NOTES ON THE LITERATURE OF EXPLOSIVES.*

By Prof. Chas. E. Munroe, U. S. N. A.

No. VIII.

In the first number of these Notes attention was called to the growing importance to the student of explosives of the new study of thermo-chemistry, and frequent references have since then added force to this suggestion; but the elaborate work of M. Berthelot, now before us, bearing the title of "Sur la Force des Matières Explosives d'après la Thermochimie," shows most strongly the necessity of conducting our inquiries into the constitution and mode of action of explosive substances from this standpoint, if we wish to arrive at any rational conclusions and to discover the general underlying principles. This work is in two large octavo volumes, of over 400 pages each, and bears the imprint of Gauthier-Villars, Paris, 1883, which is a guarantee of excellent typographical form and workmanship. The work is announced as a "third edition, revised and considerably augmented," but one would be at a loss to recognize the thin little duodecimo entitled "Sur la Force de la Poudre, 1872," as the second edition of this work.

Although in civil life, yet Berthelot has had unparalleled opportunities for the study of explosive substances; for, in addition to having served as president of the Scientific Committee for the defence of Paris in 1870, and having been delegated to fill the place formerly occupied by Gay Lussac upon the Advisory Committee on Powders and Saltpetre, he is President of the Committee on Explosive Substances, created June 14, 1878, where he has associated with him

*As it is proposed to continue these Notes from time to time, authors, publishers and manufacturers will do the writer a favor by sending him copies of their papers, publications or trade circulars.

some sixteen specialists from the Army, Navy, and the corps of Mining Engineers and Engineers of Powders and Saltpetre (among whom we note Sarrau, Sebert, Cornu, Vieille, Desortiaux and others), and in this position he has the assistance of a considerable laboratory force and all the resources of a highly centralized government at his command. It is then not surprising that, by April 5, 1883, his committee had completed twenty distinct researches, and had twenty-three others in course of execution.

The work now under consideration is based principally upon these researches, together with those of Berthelot and others in pure chemistry. The first part deals with the general properties of explosive substances, their chemical composition, the heat disengaged in their explosion, and the pressure of the gases produced; the duration of the explosive reaction; explosions by influence, and the explosive wave. The second part treats especially of the thermo-chemistry of explosive compounds, a chapter being devoted to the much-vexed question of the origin of the nitrates; and the third part considers the force of the explosive bodies. The work is replete with descriptions of the apparatus used, the methods pursued and the data obtained in these researches; but, as we have already noticed, in these Notes, many of the results as they have appeared in the professional journals, we will simply present the following tabular summary:

Nature of the explosive substance.	Formula.	Molecular weights in grams.	Heat disengaged at constant volume by one kilogram in calories.	Volume of permanent gas (1) per kilogram, in litres.	Specific pressure from experiments (3) (1 gram in 1 cm.³) in atmospheres.	Velocity of the explosive wave per second, in meters.
Oxygen and hydrogen.	$H_2 + O$	18	{ 3833 liquid water / 3278 steam (1) }	1240	11960	2810
Chlorine and hydrogen.	$H + Cl$	36.5	603	610	4940	"
Carbon monoxide and oxygen.	$CO + O$	46	1483	480	4510	1089
Ethane and oxygen.	$CH_4 + O_4$	80	{ 2669 liquid water / 2419 steam (1) }	840	11420	2287
Ethine and oxygen.	$C_2H_2 + O_5$	106	{ 3001 liquid water / 2907 steam (1) }	630	8630	2482
Ethene and oxygen.	$C_2H_4 + O_6$	124	{ 2753 liquid water / 2592 steam (1) }	720	9940	2209
Cyanogen and oxygen.	$C_2N_2 + O_4$	116	2263	580	8760	2195
Nitrogen sulphide.	NS	46	694	485	8270	"
Nitroglycerine.	$C_3H_5O_3(NO_2)_3$	227	{ 1579 liquid water / 1480 steam (1) }	713	10950	5000 in 75% dynamite.
Nitromannite	$C_6H_8O_6(NO_2)_6$	452	{ 1526 liquid water / 1459 steam (1) }	692	11500	"
Gun cotton.	$C_{24}H_{29}O_9O_{11}(NO_2)_{11}$	1143	{ 1074 liquid water / 1022 steam (1) }	859	10000	5000 to 6000
Potassium picrate.	$KC_6H_2(NO_2)_3O$	267	781	549	$\frac{5600}{n-0.14}$	"
Mercury fulminate.	$C_2H_2N_2O_2$	284	{ 463 gaseous mercury (2) / 349 }	314	{ 6200 / 27400 (4) }	"
Diazobenzol nitrate	$C_6H_5N_3(NO_2)$	167	688	818	about 7600	"
Gunpowder.	{ 74.7 nitre, 10.1 sulphur, 14.2 carbon, 1.0 water }		720 to 738	278 to 263	$\frac{2193}{n-0.68}$	"

(1) This volume represents the reduced volume. In those cases where the reaction produces aqueous vapor, the volume of this substance is included in the reduced volume, whereas in fact it is only gaseous at some temperature t higher than 0°; that is to say, the volume assigned to the aqueous vapor ought to be multiplied by $1 + \frac{t}{273}$, t being the temperature produced at the moment of the explosion. But then the heat disengaged ought to be diminished by the amount absorbed in vaporizing the water, a quantity which Berthelot takes, for simplicity, as equal to 10000 cal. for 18 grams of water. He neglects on the other hand the effect of dissociation, since the value to be assigned this has not yet been determined. (2) The mercury is supposed gaseous, as it is considered at a temperature above 360°. The real volume is then $314\left(1 + \frac{t}{273}\right)$. The heat disengaged has been diminished by the latent heat of vaporization of mercury. (3) These pressures represent the limit toward which the observed pressures tend under a *density of loading* of $\frac{1}{n}$ (1 gram of matter in n cm.³) when n tends towards unity. In the case where a non-volatile residue is produced, the volume of this residue ought to be deducted from n, as is done in the cases of potassium picrate and gunpowder. (4) In its own proper volume, that is to say, for a density of loading when $\frac{1}{n} = 4.43$.

In citing these results of Berthelot's work, it may be proper to call attention to a recent review by Prof. Remsen, *Am. Chem. Jour.* **6**, 423, Feb. 1885, of "A Treatise on the Principles of Chemistry," by M. M. Pattison Muir. He says: "Chapter IV is devoted to the *Applications of physical methods to questions of chemical statics.* Of the physical methods the first considered are the thermal methods. The subject is treated clearly; indeed, it would be difficult to find anywhere a more satisfactory statement in regard to the method and results of thermo-chemistry than we here have included within fifty-odd pages. After showing that the thermal value of even the simplest chemical change is really the sum of various changes, some of which have a positive and others a negative value, and that in most, if not in all cases, it is impossible to assign values to each of the simple changes involved, the conclusion is drawn, that until 'the distinction' implied in the terms atom and molecule' is practically recognized in thermal chemistry, we cannot expect any great advances to be made in applying the mass of data already accumulated to questions of chemical actions and reactions.'

'Berthelot's work is saturated with the conceptions of the molecular theory; but, by some fatal perverseness, he refuses to apply this theory to chemical phenomena. While recognizing the existence of molecules, and building his generalizations on a molecular foundation, he refuses to accept the conception of atom, or rather he hopelessly confuses it with that of equivalent. The molecule is for him a definite and definable portion of matter, the parts of the molecules are only numbers.'

"This criticism may sound harsh, but it appears to be just. At all events we shall be glad to hear what the disciples of Berthelot may have to say in reply. We commend this part of the book to the careful attention of those who have blindly 'pinned their faith' to investigations in the field of thermo-chemistry. While something has been learned, and much more will be learned, in regard to the nature of chemical action by a study of thermal phenomena, it must be acknowledged that the results thus far reached are extremely meagre." In this connection consult the same Journal **5**, 147 and 293, also **6**, 202.

Through the courtesy of Manuel Eissler we have received a copy of his "Modern High Explosives," in the form of a large octavo of 495 pages, published by John Wiley & Sons, 1884. The

book is arranged in three parts; the first of which describes the processes employed in the manufacture of high explosives, and the methods of analysis and chemical properties of these bodies and their constituents; the second treats of the methods for operating with these explosives; while the third deals with the principles of blasting, and gives the results obtained in many engineering, mining and military operations. Mr. Eissler designed, erected and managed the American Forcite Company's works,* and has had considerable experience in the use of high explosives, and hence he has been able to gather together and present in the last two parts of his book a large amount of information and data which will be of value and use to the practical man in determining the amount of an explosive necessary to do a given work and the best way of applying it. The first part, on the other hand, is quite unsatisfactory, as it is so marred by errors in chemical terminology and technical phrases as to be quite bewildering.

One of the most novel and interesting chapters in the book is the one on "Big Blasts," where, among other instances, it is stated that it sometimes happens in the system of hydraulic mining in vogue in California, that banks of gravel are met with which are so firmly cemented together as not to yield readily to the action of the water, while other banks are so high that it becomes dangerous to bring the stream sufficiently close for the water to exert its disintegrating force. Under these circumstances recourse is had to what is termed "bank-blasting," in order to loosen the earth so that it will break down under the pressure of the water, and enormous quantities of explosives are used for this purpose. Mr. Eissler gives a detailed description of the method of laying these charges, and he says that in the diggings at Smartsville, San Juan, More's Flat, Bloomfield, and elsewhere in California, it is an almost daily occurrence to fire blasts where twenty, thirty, and even fifty thousand pounds of explosives are used in a single charge, and that this system of large blasts is even become common in hard rock excavations, such as quarries and railroad cuttings.

We learn that a second volume is in course of preparation, and from the scope of the projected work it promises to be of great value.

A circular from the Judson Powder Company gives the following instances of "big blasts," in which this powder has been used:

* Proc. Nav. Inst. 11, 98.

June 29th, 1882, 23,000 pounds were fired in a limestone quarry at Glendon, Pa., and it is estimated that it moved 150,000 tons of rock. January 11, 1883, 29,000 pounds of frozen powder were fired at the same place with good results. At Shell Rock, on the Oregon R. and N. Co. R. R., 10,000 pounds of powder, in one charge, moved 56,000 yards of solid rock. At Jacob's Ladder, on the same road, 21,000 pounds of powder moved 110,000 yards of solid rock.

Through the kindness of Gen. Abbot we are in receipt of Addendum II of his Report on Submarine Mines,* in which the results of recent experiment on Atlas powder, Judson powder, Rackarock, Forcite, and explosive or blasting gelatine, are given.

Two grades of Atlas† powder, A and B, were used, of which the composition was:

Grade A.—Sodium nitrate,	. . . .	2
Wood fibre,	. . . . .	21
Magnesium carbonate,	. . . .	2
Nitroglycerine,	. . . .	75
		100
Grade B.—Sodium nitrate,	. . . .	34
Wood fibre,	. . . . .	14
Magnesium carbonate,	. . . .	2
Nitroglycerine,	. . . .	50
		100

The firing trial showed Atlas A to be precisely equivalent to dynamite No. 1, when fired under water; while Atlas B, under the same conditions, showed an intensity of action in the horizontal plane equal to 99 per cent. of dynamite No. 1, for equal weights.

Several grades of Judson powder‡ were tested. The one most commonly used, and which is sold at the price of common saltpeter blasting powder, is the R. R. P., which has the composition:

Sodium nitrate,	. . . . .	64
Sulphur,	. . . . .	16
Cannel coal,	. . . . .	15
Nitroglycerine,	. . . . .	5
		100

* Proc. Nav. Inst. 9, 287, 754. † Proc. Nav. Inst. 11, 116.
‡ Proc. Nav. Inst. 11, 116.

It is manufactured at the New Jersey works by first grinding the niter, sulphur and coal separately, to a fine powder, and then thoroughly incorporating them in a barrel mixer to form a coarse mealed powder. This is then heated on a steam pan (150 pounds pressure and 350° F.), and constantly stirred until the sulphur melts and coats the particles of the niter and coal. The mass is then thrown out and allowed to cool, and it forms conglomerate grains, which are sorted by sieves and coated with nitroglycerine by stirring. The theory of this manufacture is the same as that claimed by Mr. Mowbray for his mica powder, viz: the coating of a non-absorbent base with nitroglycerine, by which the quickness of explosion is promoted. The prime difference between the powders lies in the fact that Judson employs an explosive base, while Mowbray's is inert. The advantage sought for here is to obtain the maximum potential energy of the explosive base through the initial action of the small charge of nitroglycerine.* The intensity of action of the R. R. P. of different makes, fired under water, was found to equal 38 to 39 per cent. of dynamite No. 1, while some of the other grades rose as high as 78 per cent. The lower grade seemed to be insensitive to the shock of the ball from a Springfield rifle at twenty paces, and when ignited by a match, in charges of 1½ pounds, it burned for about forty-five seconds with a strong yellow flame, but with no such flashing as occurs with ordinary gunpowder.

In addition to the rackarock mentioned in these Notes,† Mr. Divine, the inventor, has patented several other formulas in which the potassium chlorate is finely powdered and mixed with nitro-benzol and sulphur, or with "dead oil" of tar and sulphur, or with "dead oil" of tar, sulphur and carbon disulphide in varying proportions. Several of these mixtures were tested and they gave results varying from 77 to 104 per cent. as compared with dynamite. Gen. Abbot seems to be favorably impressed with this explosive and recommends its trial in blasting and for use in shells.

The forcite gave results which varied, with the grade, between 88 and 133 per cent., and hence it compared favorably with Nobel's explosive gelatine. It was found that the higher grade was the more liable to sympathetic explosions, but that both those tested were much less sensitive than dynamite No. 1 under similar conditions. When the forcite-gelatine was exposed for several hours to a

* Proc. Nav. Inst. **8**, 665. † Proc. Nav. Inst. **9**, 755.

temperature of 100° F., a slight exudation of nitroglycerine was observed. The manufacturers state that the base for all grades of forcite* is mixed with a special kind of "cellulose" whose formula is $C_6H_7O_2\left\{\begin{matrix}NO_2\\C_2H_3O_2\end{matrix}\right.$, which permits them to operate and manufacture cold. As they state that in manufacturing Nobel's gelatine a temperature of 170° F. is necessary for incorporation, and that this temperature renders the nitroglycerine very sensitive to concussion and quite dangerous to transport, they claim the cold process as an advantage. A hydrocarbon is used as a solvent for the forcite mixture, and its action renders the product water-proof.

The blasting gelatine used in these experiments came from Nobel's Explosive Co. of Glasgow, Scotland. It was without camphor, but directions for easily camphorating it are given. The composition was 92 per cent. nitroglycerine and 8 per cent. nitro-cotton. The test gave the relative intensity as 142, showing this to be the most powerful explosive yet tested at the station. Its sensitiveness to sympathetic explosion was the same as that of the higher grade of forcite.

Gen. Abbot gives a tabular view and also a graphical diagram of relative intensity of the modern high explosives, as shown by the results obtained in his experiments, and he draws the following conclusions:

I. The assumption sometimes made that the economic value of a dynamite is simply proportional to the known percentage of nitroglycerine it contains is shown to be erroneous. A judiciously selected base adds enormously to the energy developed by the nitroglycerine alone.

II. There appears to be an advantage in gelatinizing the nitroglycerine before its absorption.

III. The composition of the base is practically as well as theoretically a very important matter. For example, the lower grades of forcite and rendrock, which are very similar in composition, show nearly equal intensity; and the same is true of dynamite No. 2 and Vulcan No. 2; but both grades of electric powder fall far behind these rivals.

IV. It seems to be a general law that with any particular kind of base there is an economic gain in increasing the percentage of nitroglycerine up to a certain point, but that beyond that point the advantage ceases.

* Proc. Nav. Inst. 11, 99.

The instructors in the Department of Ordnance and Gunnery, U. S. Naval Academy, have prepared a work for use in instruction in that department entitled "Textbook of Ordnance and Gunnery," 1884, in which the most modern advancements in the construction and use of ordnance and ammunition are described by the aid of many excellent plates and cuts, while the latest data are discussed according to the most approved methods. The progress in the art of gunnery is so rapid that the best textbooks and treatises soon become imperfect, and it is for the purpose of bringing the instruction into accordance with modern views and methods that this book has been prepared.

A new powder known as the Cocoa powder, and made by the Rottweil-Hamburg Powder Co. at their works at Düneberg, near Hamburg, has been exciting some attention abroad. It is formed into hexagonal prisms, with one canal, and is of the color of cocoa, whence the name. Two pamphlets issued by the firm, dated 1882 and 1883, and entitled "Trials executed with Prismatic Powder," have come to hand, from which we extract the following:

Powder in prisms of 50 mm. was tested in a 21 centimeter gun of 30 calibers length against ordinary prismatic powder. The Cocoa powder is designated as C/82, the ordinary prismatic as C/75. The results are given in the following table:

Powder.		Weight of Projectile Kg.	Muzzle Velocity. M. S.	Pressure of Gas in Atmospheres.		Energy of Projectile.		
Description.	Charge. Kg.			Rodman Gauge.	Crusher Gauge.	Total.	Per Kg. of Powder.	Per Atmosph'e Rodman Gauge.
C/82	39	140	481	1935	1975	1648	42.3	0.85
C/75	39	"	490	2680	2825	1713	43.9	0.64
C/82	42	"	499	2130	2150	1776	42.3	0.83
C/75	40	"	497	2830	2905	1761	44	0.62
C/82	45	"	519	2365	2380	1922	42.7	0.81
C/75	40	"	506	3035	2970	1827	45.7	0.60
C/82	48	96.5	606	2320	2255	1810	37.7	0.80
C/75	42	"	607	3035	3015	1814	43.2	0.60

The above figures show:

1. That the new Düneberg powder, C/82, produces about 700 atmospheres less pressure than the prismatic powder C/75, while the velocity remains the same.

2. That the powder C/82 produces 33 per cent. more energy per atmosphere pressure than C/75.

3. That with the powder C/75, a 21 cm. shell of 3½ calibers length, weighing 140 kg. attains a velocity of 500 metres, only at a comparatively high pressure of gas, whereas the new powder produces velocity at a proportionately low one.

While a charge of 40 kilos of the old pattern may be deemed too great, on account of the high pressure of gas it produces, a charge of the powder C/82 may safely be increased to 48 kilos; the pressure thereby produced, reached according to the Rodman gauge but 2615 atmospheres, according to the crusher gauge but 2570 atmospheres, the muzzle-velocity was 537 metres.

Other properties claimed for the new powder are comparatively little smoke and a slow rate of burning when unconfined. It was especially noticed at the trial that C/82 gave less and thinner smoke than C/75, which is of the greatest importance, as great quantities of dense smoke dispersing slowly may stop the firing, as was recently the case during the bombardment of Alexandria.

A grain of C/82 powder when ignited in air did not explode like C/75 and C/68 powder, but burned slowly, showing a red flame. A closed box containing 55 kg. of C/82 powder was ignited. The powder burned out in about 10 seconds without any detonation (?) whatever. It was found that the screwed lid had been loosened, without however being thrown off the box, and that with the exception of a few slight burnings the lid presented the same appearance as before the experiment. The box also escaped without any damage. This property of burning without explosion is of value in the use of powder. Another feature in the powder is that it attracts moisture less than powder of the old pattern. Experiments made with the 40 centimeter gun of 25 caliber length gave as good results as those above quoted. These experiments were made in 1882.

The pamphlet for 1883 contains data from tests with guns of various sizes. Among them we observe, that in the 28 cm. gun of 35 calibers length, with a projectile weighing 345 kg., 100 kg. of C/82 powder gave a muzzle velocity of 525 metres and a pressure by the Rodman gauge of 2325 atmospheres, and by the crusher gauge 2350 atmospheres. Both pamphlets contain tabulated results of many trials.

It has been tried in Russia in small arms, and in France in large grains, and is reported to have given good results. A resumé of some of the firing trials will be found in the *Revue d'Artill.* **21**, 77 and 475, 1885.

In the *Jour. Roy. United Service Inst.* **28**, 379, 1884, under the subject of "Gunpowder considered as the Spirit of Artillery," Col. Brackenbury, R. A., says that two firms in Germany are making the above mentioned powder, one calling it Cocoa and the other Brown Powder. The proportion of sulphur in its composition is small, and the charcoal, if we may so call it, is different from that generally made. When first brought forward it was irregular in its action, but later samples have given very good results, about the same as Waltham Abbey C_2, and with a less amount of powder. They are prepared to make it at Waltham Abbey if its value is established, but some claimed that its erosive action is too great.

Considerable space is devoted to the subject of blending powders, and cuts are given illustrating the method followed. In this connection he says an idea has lately been set afloat that this process can be got rid of and powder made so regular that it will need no blending, but up to the present time there appears no prospect of any such consummation. Gunpowder is such a nervous and sensitive spirit, that in almost every process of manufacture it changes under our hands as the weather changes. Sometimes its sensibility can be detected and allowed for, as in the process of pressing it into moulds, when we can by actual trial tell what densities we are getting, and give more or less pressure as is required. For instance, on the morning of the 13th June, 1882, the pressure had to be applied for 45 seconds to obtain the required density. Later in the day only 29 seconds were required to obtain the same density, so that in the morning of a June day half as much again time was required as in the afternoon. On the 30th June, 1882, during part of the day the time was as short as 26 seconds; on the 11th December the time varied between 98 and 84 seconds to get the same density as was obtained in June. In the other stages of manufacture we have no such indications as in the pressing process, but it is a fact that not only the warmth of summer and the cold of winter affect it greatly, but the morning mists, the sunshine of midday, the dews of evening, yea, even a passing cloud, tell upon its nervous temperament. As a mitigation of the weather difficulty, they are to try warming a set of houses with warm water.

Under the title "A Flashing Test for Gunpowder," Chas. E. Munroe discusses in the *Jour. Am. Chem. Soc'y*, **6**, 7, 1884, the merits and defects of the method in use as described in the "Ordnance Instruc-

tions U. S. Navy," p. 345, and Smith's "Handbook of the Manufacture and Proof of Gunpowder," p. 83, and the suggested improvement of Marvin in his "Objects and Resources of the Naval Experimental Battery," p. 18, and also the pyrographic method invented by Colonel Chabrier, and described in the *Comptes Rendus*, **78**, 1138, 1874, and the *Revue d' Artillerie*, **4**, 396, 1874. He then describes his own process, which consists in flashing the powder on a sheet of dampened paper which has been coated with Turnbull's blue—in fact, such blue paper as is produced in the "Blue Print Process" of photography. The result will be that if the paper is washed, after a half minute exposure to the action of the powder residue, it will be found covered with yellowish or white spots, that have been caused by the action of the alkaline salts which result from the combustion, and which have the power to discharge the blue color; and the author holds that the fineness of the spots and the uniformity of their arrangement about the explosive center are determined by the thoroughness of the incorporation of the powder.

The advantage which is claimed for this new method is, that as the test papers, when dried, remain unchanged for years, they may be filed at the factory with other data concerning a given powder, or that, in the case of the government, they could be inclosed with the quarterly returns of the inspecting officers at distant stations, to be examined by some expert in the Bureau. Specimens of the tests of standard powders could also be furnished inspecting officers, to guide them in the interpretation of the results of their tests, and finally, a sample of the required test might be attached to the specifications for a gunpowder to be purchased. A detailed account of the method can also be found in the Text-book of Ordnance and Gunnery, U. S. N. A., p. 93, 1884, and Van Nostrand's Eng. Mag. **32**, 427, May '85.

We are in receipt from Luckhardt & Alten, Cassel, Germany, of a thin pamphlet, entitled "A Few Words on the Present State of the Manufacture of Gunpowder," in which it is claimed that the German gunpowders are now superior to those of all other countries, and are largely purchased by foreign governments, and that the superiority is due solely to the severity of the tests applied to the materials and the manufactured product, and to the delicacy and accuracy of the instruments employed in making these tests. The pamphlet then describes, with illustrations, a considerable assortment of apparatus

which this firm supplies, and among them, besides the densimeters, chronographs, pressure gauges, and the like, we especially note an apparatus for measuring the length of cylinders in crusher gauges, which it is claimed will measure a difference of $\frac{1}{10}$ of a millimeter ($\frac{1}{1000}$ of an inch), another for measuring the length of cut in the Rodman method, which will read to the $\frac{1}{100}$ millimeter ($\frac{1}{2500}$ inch), and another still for measuring the thickness of wire and width of mesh in metallic powder sieves, which also reads to the $\frac{1}{100}$ millimeter.

The newspapers for some time past have contained notices of the dynamite gun now on trial at Fort Hamilton. One of the fullest descriptions, with an illustration, is to be found in the *Scientific American* **50**, 214, April 5, 1884. This represents the 4-inch gun building at the Delamater Iron Works, N. Y. It consists of a brass tube, 40 feet in length and $\frac{1}{4}$ inch thick, mounted on a high steel girder. The latter is trunnioned and is pivoted on a cast-iron base, thus enabling it to be swung into any desired position and range. To assist in the latter operation guys are placed on either side of the base, and their length can be altered and fixed by means of hand-wheels.

Compressed air is introduced to the gun from below and passes up through the center of the base, the pipe connecting with one of the trunnions (which are hollow); it is then carried into a pipe at the side of the gun which leads into the valve. This valve is a continuation of the breech of the gun, with which it is connected by a short passage.

An important feature of the system, and one upon which the success of the undertaking greatly depends, is the projectile, or dart. It consists essentially of two parts, and while several different modifications have been tried, the principal features are alike in all of them. The forward part of the dart consists of a thin brass tube, into which the charge of dynamite is inserted. At the rear the tube is enclosed by a wooden plug, which flares out towards the rear until its diameter equals that of the bore of the gun. The forward end of the brass tube shows a mass of some soft material, into which is inserted a pin firmly held in place, the end being closed by a conical metal cap. Provision has also been made to allow a certain amount of air to act as a cushion for the dynamite cartridge, thus lessening the shock due to a sudden discharge. It is therefore claimed, that under ordinary circumstances there is little danger of the charge exploding,

since the pin cannot reach it and ignite the fulminate at its end; but when thrown from the gun, the impact against a body will displace the soft material and drive the pin home, causing an explosion. Another feature of the projectile is the power which it possesses to correct, to a certain extent, the deflection due to a side wind. It will be noted, that with the present construction, the centre of gravity of the dart is some distance forward of its centre of figure. A side wind acting upon the lighter rear part would therefore have the tendency to deflect it so as to turn the head of the dart into the wind, which action would, in a measure, tend to keep it in the line of its trajectory.

The firing of the gun, if the expression may be used, is accomplished in the following manner: The dart is inserted in the breech, and a gas check placed in position; a lever then being moved, the valve is opened and the air pressure admitted. This method of discharge will, it is thought, obviate the danger of the shock, which had heretofore proved a stumbling block to success; and in addition, the valve-controlling mechanism is automatically arranged to admit the air, gently at first to overcome the inertia of the projectile, following with full pressure, and finally closing at the proper time as the dart leaves the gun.

Experiments made thus far have shown that the apparatus can be depended upon for a fair degree of accuracy and rapidity in firing. As regards the range attainable, the two-inch gun now being tested has attained 1¼ miles with a pressure of 420 pounds to the square inch. In the four and six-inch gun which are in course of construction, it is intended to use pressures of 2000 pounds and over, by the use of which they hoped to attain a range of three miles. Advantages claimed for these guns are lightness and ease of manufacture.

The Washington *Sunday Herald* of March 17, 1884, states that the experiments with dynamite shells have proved less efficient than was anticipated, as they have no penetration, and the explosion takes place on striking. The issue of March 30 narrates that a workman at the Delamater Works tried the 4-inch gun with a piece of cotton waste. Although only a 100 pounds pressure was put on, the waste was blown through a wooden door two inches thick, making quite a large breach.

The idea of employing the expansive force of steam, or of compressed air, for propelling projectiles is not a new one, but its application has not heretofore met with success, since penetration

has been sought for. Among other contributions to the subject is a paper "On the Numerical Expression of the Destructive Energy in the Explosions of Steam Boilers, and on its Comparison with the Destructive Energy of Gunpowder," by G. B. Airy, *Phil. Mag.* [4] **26**, 329, 1863. He reaches the conclusion that the destructive energy of one cubic foot of water, at the temperature which produces the pressure of 60 pounds to the square inch, is equal to that of one pound of gunpowder.

In Richardson & Watts' "Chemical Technology," Vol. I, Part IV, page 523, London, 1865, we also find the following: "High pressure steam is exceedingly well adapted to the performance of this kind of work; unluckily it would require high pressure steam of 400 atmospheres or 5000 lbs. pressure on the round inch to perform this duty, and as such steam could only be generated in a furnace intensely heated, it is scarcely probable that boilers will be found sufficiently strong and durable to work continuously under such pressure. If they were found to be practicable, nothing more would be necessary than to bring a steam pipe from the boiler to the breech of every gun in a fortress or a ship, and the admission of the charge of such steam into the chamber by a valve would be sufficient to discharge the missile of the 68-pounder with a speed of 1600 feet a second. The well-known Mr. Perkins studied this subject carefully, but applied it somewhat differently. He found that steam of this pressure could be generated only by water nearly red-hot; and instead of throwing the steam into the breech by a pipe, he threw the red-hot water into the breech of his gun, allowing it when there to expand itself into steam and expend its force in giving speed to the ball. This expedient of Perkins is well worthy of study. It has both the defects and advantages of a gunpowder gun. The red-hot water thrown into the barrel would have the fault of being too powerful at the beginning of its expansion and too weak at the end. The barrel would be filled partly with water and partly with steam; and as the water grew into steam it would lower its temperature and its pressure, so that the explosive force would fall off very much towards the end of the stroke. This is the inevitable evil of allowing the water to become vapor in the gun. When the steam is generated in a separate boiler, and freely admitted into the breech of the gun, there is reservoir enough of heat and steam to maintain the even pressure in following up the ball from the breech to the muzzle. It is the evil of charges converted into gas within the breech of the gun, that their temperature and pressure are too high at starting and too low at the

end. The steam-gun would in this respect be the best of our projectile forces.

"Compressed air has many of the advantages and some of the defects of steam; and the frequent use of the air-gun has shown its convenience as well as its efficiency. Air can be compressed into a reservoir by mechanical force, just as steam can be raised in a boiler by heat; and by compressing 400 times the natural quantity of air into a given space, a pressure of 400 atmospheres might possibly be obtained in this way. If an air pipe communicated from this reservoir to the breech of our gun, air of 400 atmospheres of pressure would certainly be able to follow up the 68-pounder shot, with pressure and velocity able to discharge it with a speed of 1600 feet per second, and, therefore, to do our work; but the apparatus would be full of mechanical difficulties.

"Liquid gases are known to be receptacles of enormous mechanical power. Carbonic acid gas, liquefied and shut up in a reservoir, generates large volumes of gas with great rapidity the moment it is permitted to expand. Other gases expand with still greater rapidity and force; and if we could conceive liquid gases to be easily made, safely carried, and comfortably handled, a charge of liquid gas bottled up in the breech of a gun would be a very effectual propelling power, and quite able to generate the force we want, and to apply it within the time we require. This system, however, is also beset with mechanical difficulties.

"The preceding illustrations of steam, compressed air, and liquid gases lead us on very instructively to the manner in which fire has become necessary to do the work of a gun. A supply of heat is essential to the expansion of a gas, and a rapid supply is indispensable to the rapid performance of the work. In steam, the fire is not only external to the gun, but external to the boiler in which the steam is generated. In gunpowder, the fire is introduced into the inside of the gun, for the purpose of supplying the heat that is wanted to raise the gases to their elastic pressure, and to maintain them at that pressure while expanding. Red-hot steam introduced into the breech of a gun rapidly cools down and loses its heat and power in expanding. If we could introduce fire into the breech of the gun at the same time, to maintain the heat of the steam and the water, the steam would become an admirable propelling force. Carbonic acid gas expanding rapidly from the liquid into the gaseous state cools down so suddenly as not only to lose its mechanical power, but to

freeze into solid flakes of snow. If we could charge the breech of the gun with fire as well as with liquid gas, the fire would give it the heat it wants, prevent its congelation and maintain its power to the end of the discharge. What gunpowder and gun-cotton do is really to provide a reservoir of gas and a fire to heat it simultaneously and in the same chamber. In the case of gunpowder the fire is fed with charcoal, in the case of gun-cotton the fire is fed with gun-cotton wool—another form of carbon. In gunpowder, large quantities of carbonic acid gas are generated, possibly in the liquid state, and are heated by the internal furnace of the charge, possibly red-hot. In like manner in a gun-cotton charge, red-hot water or steam is introduced with other gases, possibly also liquids, together with an internal furnace of flame; and thus the work is done—first, by the release of the gases themselves, and, secondly, by the continuance of the elasticity of those gases by the internal supply of heat. This is how gunpowder and gun-cotton really do the work of a steam-gun, a carbonic acid gun, or any other kind of gas gun."

Prof. R. H. Thurston treats of the same subject in the *Jour. Frank. Inst.* **88,** 427, December 1884, under the title "Steam Boilers as Magazines of Explosive Energy," and after referring to the above mentioned paper of Airy's, and that of Rankine "On the Expansive Energy of Heated Water," *Phil. Mag.* [4] **26**, 1863, he has computed, by the aid of the formulas of Rankine and Clausius, the magnitude of the quantities of energy residing in available form in both steam and water, for the whole usual range of temperatures and pressures familiar to the engineer, and also for those beyond, which have only been attained experimentally, but which are likely to be reached in the course of time, and he has plotted curves of the available energy of heated water, of latent heat and of steam, and the explosive energy of many different forms of boilers.

The dynamite air-gun is also described with illustrations, and discussed by Chas. E. Munroe in *Van Nostrand's Eng. Mag*, **32,** 1, January, 1885, in a paper entitled "Some Recent Experiments on the Use of High Explosives for War Purposes."

In determining the efficiency of the air-gun projectile against an armor-clad vessel, the author assumes that one of four effects may be produced, depending on the resistance of the armor to penetration, and on the material, thickness of wall, profile, weight and velocity of the projectile.

(1). The projectile may either penetrate the armor partially and explode in place, or pierce it completely and burst inside of the ship. This is the condition of greatest efficiency.

(2). It may explode immediately upon impact, and before breaking up. Then the explosive will exert the energy which it develops through explosion in a resisting receptacle.

(3). It may rebound before exploding. Then the effect will be reduced by the interposed cushion of air.

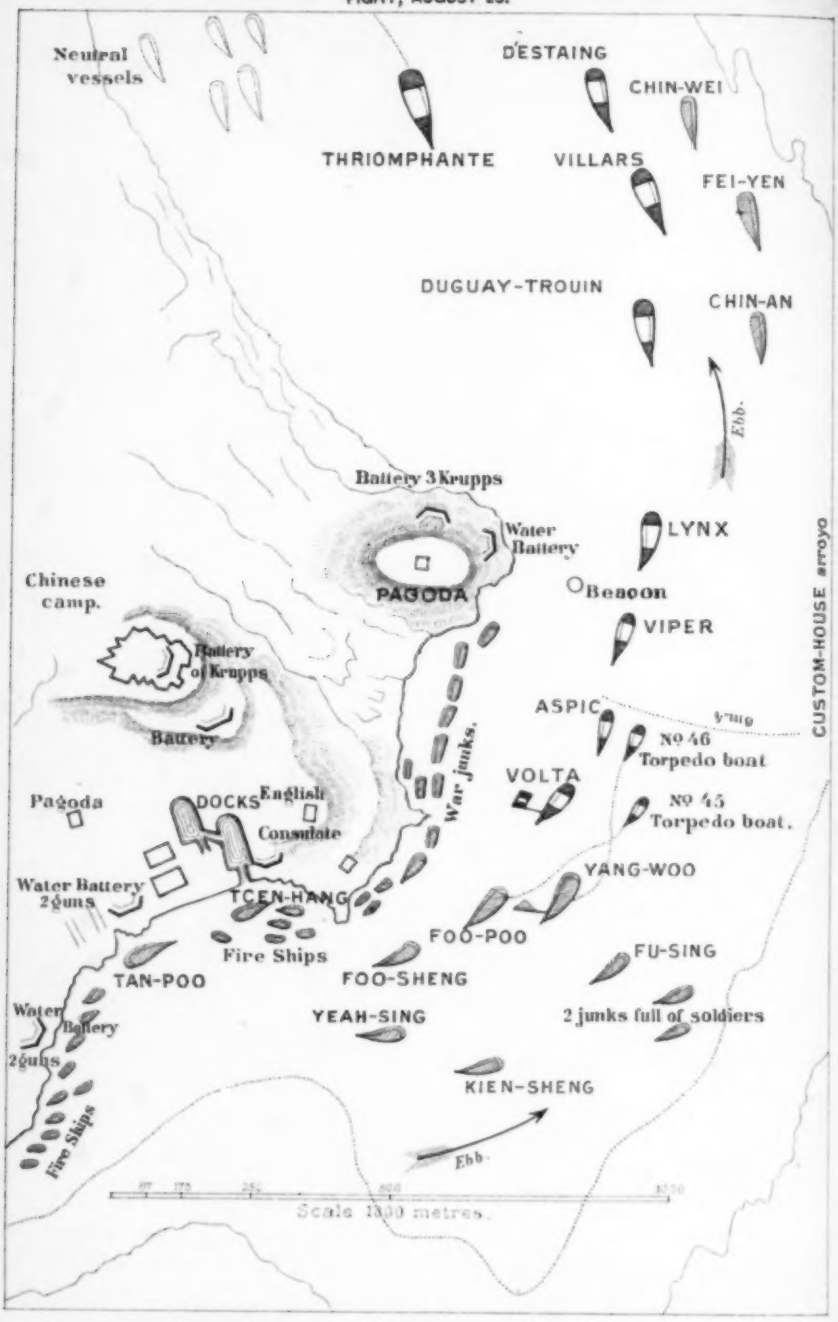
(4). It may break up on impact before the explosion takes place. Then the energy of the explosive will be simply that which it develops when exploded unconfined.

The resistance of an armor to penetration depends upon its hardness, its tensile strength (that due to bolting as well as that inherent in the metal itself), and its inertia. The latter is augmented by the thickness and weight of the armor, and by the rigid system of bracing which now obtains in practice. How great this resistance is can best be illustrated by an example. While, from the fact that very rapid progress is being made in the improvement of armor plates, we may have not chosen the best example, let us take the steel plates designed for the Furieux. One of these, weighing 23 tons, 9 cwt., and averaging over 17 inches in thickness, was tested at Gâvre, July 13, 1883. Three shots were fired against this plate from a 12.6-inch rifle using chilled iron projectiles, weighing 759 pounds each. The first and second shot struck with a velocity of 1403 feet each. The third struck with a velocity of 1438 feet. The projectiles were all broken up, all of the twenty bolts through the plate remained intact, and no portion of the plate fell from the backing, although it was somewhat indented and cracked.

Although we are not yet informed concerning the air-gun projectile, except for the weight given above and the pressure of the air also cited, yet when we remember that in the Gâvre experiments the pressure of the powder gas probably approached 40,000 pounds to the square inch, it is not unfair to infer that with a pressure of 500 pounds to the square inch a projectile will possess little or no penetrative power against the Furieux plates at a distance of 1¼ mile. Whether then the projectile would explode on impact or after rebounding, or whether it would break up before exploding, is a matter for speculation and conjecture. If the last condition prevails, then we can judge from some experiments recently made at the Naval Experimental Battery, what the destructive effect would probably be.

In these experiments Commander Folger detonated upwards of 400 pounds of dynamite, in charges of from 5 to 100 pounds, against a wrought-iron target, eleven inches thick, without damaging the plates. These charges were enclosed in cartridge bags and suspended against the plates. Commander Folger concludes from these experiments "that it is a matter which hardly admits of doubt, that a modern armor-clad will not be materially injured by the explosion, in superficial contact with her over-water plating, of charges of more than 100 pounds of dynamite."

POSITION OF THE FRENCH AND CHINESE VESSELS AT THE BEGINNING OF THE FIGHT, AUGUST 23.



NOTE.—The spelling of the names of the Chinese vessels upon this sketch differs from the spelling of the same names in Admiral Courbet's report. It is copied from an English proof which indicates in a very precise manner the armament of these vessels. Exception is made for the two alphabetical gunboats. The spelling of their names, as they do not appear on the English sketch, is similar to that in the Admiral's report.

NAVAL INSTITUTE, ANNAPOLIS, MD.

THE COMBATS ON THE MIN RIVER.

From the French of Captain Chabaud-Arnault, F. N., in the Revue Maritime et Coloniale.

TRANSLATED BY LIEUT. E. B. BARRY, U. S. N.

I.

Admiral Courbet's report of the combats on the Min River is so complete and so precise, that it enables us to follow their stirring phases, and appreciate from a naval and military point of view their great value.

There also flows from these well executed operations, which have added a glorious page to the annals of our fleet, much useful instruction. They happen at a time when everything pertaining to naval equipment is discussed with passion, warmly controverted and criticized without stint. Hence, while possessing somewhat of an original character attributable to the circumstances that gave them birth, nevertheless these combats confirm, or complete, many precious lessons due to the study of less recent maritime events.

The forces opposed to each other the morning of the first fight, that of August 23, 1884, were as follows:* On our side, 7 men-of-war, all wooden cruisers or wooden gunboats, without belt or side armor. Only one of these vessels carried 5 19 c. guns (7.48 inches), the others carried generally pieces of 14 c. (5.51 inches); total number of guns in our squadron, 58. Besides these guns, however, both cruisers and gunboats carried Hotchkiss revolving cannon and rapid firing muskets, excellent arms, which we shall see later rendered good service. To these 7 wooden vessels, under the command of

* Admiral Courbet's report itself serves as the base of our work. We owe the complementary details found in this essay to the extreme kindness of several of our comrades.

Admiral Courbet, we must add 2 torpedo boats, 27 metres long (88 ft. 6½ inches), whose action against the Chinese light squadron might be very efficacious and even decisive. Finally, a quarter of an hour after firing began, the ironclad Triomphante, kept at a considerable distance from the principal theatre of the struggle by her draught, nevertheless gave to our squadron the support of her 6 24 c. guns (9.44 inches).

Commanded by a chief who knew how to inspire them with absolute confidence, our sailors are filled with ardor. The greater part of them already have spent many months on board their vessels. They know their officers, to whom they are attached by the thousand ties created by a long voyage, perils faced, success conquered, as well as reverses encountered together. Well versed in all exercises aboard ship, nevertheless they were compelled to supplement them on account of the absence of all land force. Even counting several detachments drawn from the vessels outside the Min River, Admiral Courbet could not land more than 600 or 700 men, of whom many doubtless had neither the time nor the opportunity for complete military instruction looking to such an undertaking.

The Chinese flotilla in the Min River consisted of 11 vessels, cruisers, transports, despatch boats, and gunboats, carrying altogether 56 guns, 2 of 25 c. (9.84 inches), throwing shell or shot of 185 kilogr. (411.4 lbs.); 1 of 20 c. (7.87 inches), throwing an 82 kilogr. projectile (180.4 lbs.); 2 of 18 c. (7.09 inches), projectile 53 kilogr. (116.6 lbs.); some of 16 c. or 15 c. (6.3 or 5.91 inches); and finally, about 30 Vavasseur guns of 13 c. (5.12 inches), throwing 25 kilogr. (55 lbs.) projectiles. All the Chinese ships are wooden, without armor; of elegant appearance, but light build. Their hulls are more or less protected against sinking by water-tight bulkheads. The displacement of the largest and smallest respectively, 1400 and 250 tons. Their very numerous crews are without revolving cannon or mitrailleuses, but they have muskets and other small arms of perfect model. If you add to these 11 ships 9 war junks, each possessing a middling armament of small calibre smoothbores, two other very large junks filled with soldiers, and carrying 2 or 3 cannons, 7 ordinary steam launches and 3 or 4 row-boats, all carrying in the bow spar torpedoes, you will have the total of the naval force opposed to the French squadron.

This force is supported not only by a numerous infantry established in the neighborhood of the Foo-Chow arsenal, but also by

6 or 7 batteries, of which 2 are each armed with 3 Krupp guns of rather feeble calibre, but which can do much injury to our ships.

Truly, Chinese troops and Chinese crews are worth little, if one compares them with analogous forces of any European power. Still one must guard against completely despising them. They are no longer the undisciplined soldiers without experience or military disposition, firm enough behind good walls, but worthless, or nearly so, in the open field, that were opposed to our troops during the campaigns from 1857 to 1860; still less are they the grotesque combatants so rudely handled by the English from 1840 to 1842. They will be seen before the fight, provoking our sailors, according to the fashion of Homer's heroes, by cries and insults. This is not entirely a vain boast. Most of these men are brave, they will give many proofs of it. Many had received their military instruction under European officers; they can move in unison, fire by command, and intelligently perform skirmish drill. Happily for us, their leaders are worse than poor; their artillerists, with a few exceptions, as unskilful as formerly.

After having indicated the number and the nature of the forces present, let us show how they were distributed and arranged before the fight. To understand this it will be necessary only to glance at the accompanying sketch.

Our squadron had been in the Min River for a month, from day to day waiting for the order to begin hostilities. The dispositions for action had been made. The Chinese vessels attentively watched and imitated the movements of ours. One can comprehend how trying this situation was, how enervating even for our crews, whom the enemy could attempt to surprise by an unexpected attack, who saw accumulating every day abreast of our ships and behind them, junks, fire-ships, land batteries and infantry. The Chinese hoped the French squadron never would be able to get out of the Min River. Knowing well the evening before that we would open fire August 23d, from the morning of that day they do not spare us hostile demonstrations. The ships of the two nations are riding to the flood under steam, ready for combat. During several hours the situation of the Volta and our three gunboats, all four anchored above Pagoda Point, was critical. For, in case the Chinese took the initiative, the three vessels anchored below the Pagoda, near the Duguay-Trouin, the Villars and the d'Estaing, could get under way without noise, the current would carry them quickly abreast of the

port (starboard?) side of the Volta and our gunboats, where our large cruisers, stopped by their draught of water, could not follow them. Fired upon on one side by three ships, on the other by the junks and land batteries, and attacked in the rear by Chinese ships stationed above, the Volta, the Aspic, the Vipère and the Lynx can be overwhelmed by a crushing force. Happily, nothing of this kind takes place, and the tide turns ebb. We are going to have the double advantage of position and of the offensive. From this time the Chinese fleet is doomed. At the very outset the three fine ships imprudently left below exposed to the fire of our large cruisers will be rendered in a few moments motionless and *hors de combat.* Two other vessels, despatch boats and transports, each carrying four cannon, are secured to the quays of the Foo-Chow arsenal; they do not count in the action. Aided by our two torpedo boats, sustained against the shore batteries and the junks by the artillery of our large cruisers, the Volta, the Aspic, the Vipère and the Lynx have every chance to overcome the six other Chinese vessels.

II.

It is 1.45 P. M. At a signal from the Admiral our two torpedo boats are directed at moderate speed against the enemy. No. 46 against the cruiser Yang-Woo, 1400 tons, the largest Chinese vessel; No. 45 against the transport Foo-Poo, 1258 tons. The torpedo boats were about 300 and 500 metres respectively from their objective. The torpedoes are charged with 12 or 14 kilogr. of gun-cotton. On account of the current, the torpedo boats, following the course necessary for attack, cannot reach the enemy for about one minute and a half. Our squadron has opened fire, but the Chinese vessels, although on their guard, have no time to discharge a single projectile at the torpedo boats. Perhaps having already slipped, they are also without speed.

No. 46 exploded her torpedo by contact against the Yang-Woo's port side amidships. Injured beyond remedy, but still able to use her engine, she headed quickly towards the bank, where she ran aground. The torpedo boat got clear without difficulty and began to retire. Just at this moment a small shot or a canister shot pierced the boiler. This accident caused no direct loss, as the crew rushed on deck, but one of the men was killed there by a musket ball. Carried by the current, No. 46 soon was sheltered from further injury.

Her torpedo spar was bent so that the two parts formed an angle between them of about 90°.

Less successful in her attack, drifted by the tide, No. 45 only reached the port quarter of the Foo-Poo. She struck the Foo-Poo at full speed, and only began to back at the moment contact produced the explosion. Her fir buffer was broken completely, but the hull was uninjured. The explosion bent the torpedo spar at the point of junction of the two parts so that they formed an angle of about 130°, yet the short staff and the forked portion were almost intact; although yielding to the action of the current, No. 45 is checked and held to the Foo-Poo's stern by the short staff and the fork, which probably have fouled the screw of the Chinese vessel. In vain she backs, the critical situation continues and may cause her loss.

Struck beneath the fleeing forms on her decks, the Foo-Poo was preserved from immediately sinking by the thickness of her heavy stern and by her water-tight bulkheads. Roused from their stupor, the crew opens a heavy musketry fire upon No. 45; besides they throw shells upon her decks, and probably hand grenades also, which happily do not explode. Backing producing no result, the captain of No. 45 reversed the engine, which immediately disengages his vessel. It is at this time he is struck in the eye by a bullet and one of the crew is wounded in the arm.* Nevertheless, he retains command and superintends the vessel's retreat, and she, followed for a few moments by the Chinamen's bullets, is soon out of danger.

In short, the success of our torpedo boats is complete: for, even though the Foo-Poo was not injured as badly as the Yang-Woo, nevertheless she was injured so badly as to be unable to prolong her resistance. It is now necessary to examine under what conditions this success was obtained. We must notice that this is the first case of concerted action between torpedo boats and ships, and otherwise

* The sheet-iron dome that protects the captain and the steersman of a torpedo boat is, as is well known, pierced with little glass windows that can be opened or shut at pleasure. In order to diminish these openings when not closed by the glass, the captain of No. 45, Mr. Latour, had fitted over each of them a little steel mask, that, by means of a hinge and a screw, could cover the opening or remain raised like a screen. Lowered, this mask completely covered the window opening, but itself showed a slit only 12 c. (4.72 inches) long and 1 c. (.39 inch) wide, through which the captain peered. Very probably, the bullet to which Mr. Latour owes the loss of an eye penetrated in ricochetting through this little slit.

than by surprise. Even in the two attacks in broad daylight on the Danube against a Turkish monitor, by Russian torpedo launches, they tried to hide themselves behind the islands, the points, or the reeds in the river. Entirely different is the character of the action of August 23, 1884. Our torpedo boats operated as above in broad daylight, but more than that, against a forewarned enemy; a circumstance that in presence of adroit adversaries, vigilant, well armed and prepared, is the most unfavorable for the assailant. In the present case, on the contrary, no serious consequences resulted from this. Our torpedo boats, that had the good luck to be able to take post 400 metres (¼ mile) from the enemy, crossed this distance before the Chinese had the idea, the time, or the possibility to fire a projectile, not even a bullet at them. They thus reached stationary ships, without revolving cannon or mitrailleuses, unprotected by any exterior defence; neither counter torpedo boats, nor floating stockades, nor nets. Only one thing could interfere with the attack, the force of the current, which is probably from 3 to 4 knots. Note, however, that this current singularly aids their retreat when shrouded in thick smoke, and covered by the fire of our squadron, so superior from the beginning to that of the Chinese.

One must not be deceived regarding an attack in every way favored, except by daylight; one must be careful not to believe that a similar *coup de main* could be attempted against any other than the Chinese navy. Two torpedo boats attempting such a thing under similar conditions, would be riddled by small shells, grape, and canister, before attaining their objective.

A question naturally suggests itself here: could boats discharging torpedoes have been able to attack the Chinese ships, August 23, with equal or superior chances of success to those of spar torpedo boats? We do not hesitate to reply in the negative. Examine the subjoined sketch. The spar torpedo boats reached the Yang-Woo and the Foo-Poo while steering, during the attack, in the dead angle astern of these ships, so as to avoid their artillery fire; it was only at the last moment they manœuvred to describe the curve that enabled them, under favorable circumstances, to strike the enemy's bilge. A boat discharging torpedoes, obliged to place herself bows on, 100 or 200 metres forward of the beam of the vessel attacked, because it is necessary to allow for a strong current, would have been compelled necessarily to traverse twice as long a distance; besides it would have been compelled to leave the dead angle of the Chinese guns much

sooner. Rallying from the first moment of surprise, the enemy would have had one or two minutes in which to point his guns, and who knows but that a shot fired at a range of from 200 to 400 metres (219 to 437 yards) would not have rendered the torpedo boat unserviceable? In any case, she would be exposed during the first part of her escape, to these dangers.

However, let us suppose the discharger preserved from all harm during her offensive movement. Can one believe that the Whitehead or even the two Whiteheads discharged by her, across a 4 knot current, with all the pointing errors that can happen during the smoke and excitement of battle, with all the causes of deviation to which these engines are liable by the method of their use, the nature of their construction, and their low velocity considered as projectiles; can one believe these two Whiteheads would have had the surety of action of a simple torpedo carried by the boat itself directly to the enemy's side? And even if their "direction-pointing" was excellent, could they not pass easily, being regulated for 3 metres (9 feet 10 inches) of immersion, under the keels of the Chinese vessels, of which several should not have had a greater draught than this 3 metres? In the absence of attempts at an anchorage, crowned with incontestable success, but discussed, prepared, studied and executed in a liberal spirit, with chosen machines, maintained and regulated as in a physical laboratory; in the absence of these attempts, we do not think the affirmative can be sustained.

III.

We said the Chinese had prepared a certain number of torpedo launches. These small craft, prodigal of empty demonstrations against our ships before the opening of hostilities, did not even appear during the action. However, Admiral Courbet had taken precautions against them. Our steam launches were armed, and were to prevent them from approaching the larger vessels. Manifestly, under these circumstances, they were to perform the duty of "counter torpedo boats." It will not be useless to state this in view of certain writings, in which the idea of thus protecting ships against attacks by torpedo boats is rejected from the very outset as not worthy of discussion. During the blockade of Callao, the Chilian ships and the Peruvians, their adversaries, protected themselves by means of steam launches against the attacks of the enemy's torpedo boats. An

encounter between these boats resulted, and two of those engaged, one of each party, were sunk. The measures taken in this respect by Admiral Courbet seem to show to practical minds that the creation of a special fleet of "counter torpedo boats" is already a fixed idea. What our ordinary steam launches could do against similar craft only, truly swift boats, provided with a photo-electric apparatus, armed with revolving cannon, with hand torpedoes, etc., would be able to do against speedy torpedo boats.

After the naval engagement of the 23d August our steam launches pursued the Chinese torpedo boats and rendered many of them unfit for service. Several of them, however, reappeared during the two following nights and disturbed those of our ships below Pagoda Point. Notably the 25th, at 4 o'clock in the morning, two of them attempted a surprise. The first steered for the Vipère, anchored at the head of the French line; her torpedo spar rigged for attack. Seen by one of that ship's sentries, who fired his musket at her, she changed course to reach the Duguay-Trouin.

Alone of our vessels present at the Pagoda anchorage—at least so we believe—this large cruiser and the ironclad Triomphante were furnished with photo-electric apparati. Thanks to the luminous rays of these apparati, the Vipère was enabled to point her Hotchkiss guns with so much celerity and precision that she sank the Chinese boat in the twinkling of an eye. As for the second torpedo launch, she was discovered as well and followed by the electric lights. Her crew had barely time to abandon her before she met the same fate as the first.*

This fact, of but little importance in itself, is, however, of great interest at the present time. Has it not been written that "large vessels will seek in vain to obtain light by means of the electric light," to defend themselves against torpedo boats, that "whoever has seen this light employed aboard ship easily will be convinced that it interferes with our powers of vision more than it aids them, while at the same time it indicates with certainty to the enemy's torpedo boat the position of its mark"; that after having discussed "in every navy the question whether revolving cannon will render torpedo boats *hors de combat*, they have answered it, nearly everywhere, in the negative"?† The prompt destruction of two Chinese torpedo

* Report of the captain of the Vipère.

† Les torpilleurs autonomes et l'avenir de la marine. Automatic torpedo boats and the future of the navy. By M. Gabriel Charmes, pp. 21, 50, 45, etc.

launches, by our revolving cannon, aided by the electric light, shows how exaggerated, one even might say how manifestly erroneous, these statements are. We know well the Chinese torpedo launches were slow and badly handled—in a word, resembling in no sense real torpedo boats; the attack was, therefore, under conditions very inferior to the defence. Nevertheless, the defence did not make use of all the means that can be used to-day by an ironclad squadron at anchor. Our eight vessels had only two electric light apparati to illumine all the approaches; all will agree these were few. They were not protected by any exterior defence. Their crews, fatigued by two days' fighting and a night of terrible anxiety, which was, using Admiral Courbet's expression, "a continual qui-vive"; their crews paid but little attention to this tardy alarm, on the morning of the 25th at the close of a second night that had been passed, up to this time, in perfect calm. Yet, thanks to the electric light and revolving cannon, the Chinese torpedo boats did not have even the time seriously to menace our vessels. Certainly the clear rays thrown by one around its centre, and the hail of little shell thrown by the other, will not suffice always to protect one or more vessels against the attack of numerous swift and well-handled torpedo boats. But it is permitted to affirm that often they will contribute powerfully towards obtaining this result.

IV.

The 23d, at 1.45 P. M., at the same time that the torpedo boats Nos. 45 and 46 were moving rapidly upon the Foo-Poo and the Yang-Woo, our vessels opened fire all along the line. It is only necessary to read Admiral Courbet's report and to glance at the subjoined sketch to acquaint oneself with the situation at the beginning of the combat. The Volta, as well as the gunboats Aspic, Vipère and Lynx, are underway. Their crews are reinforced by detachments from the ironclad La Galissonnière, outside the Min.

"The Volta, while sustaining the attack of the torpedo boats with her port battery and musketry, is to open fire to starboard upon the war junks, her principal mark. At the same time the Aspic, the Vipère and the Lynx leaving the Volta to starboard, will steam rapidly as far as the arsenal and engage the three gunboats and the three transport and despatch vessels there. . . . . The Duguay-Trouin, the Villars and the d'Estaing are to reduce the three vessels

anchored near them with one battery and enfilade the junks with the other. . . . . This plan is executed with perfect accord."*

While passing the war junks, anchored near the shore between Pagoda Point and the arsenal, our gunboats can give them two or three broadsides. The captains of the guns kept them trained until fire was opened, the indicated distances are mathematically exact, so that our first shots struck the enemy with great precision. The Chinese replied with a hail of projectiles, happily nearly all badly directed. It is almost calm, and after a few minutes a thick smoke covers the scene of battle. Our gunboats and armed launches are engaged in a sort of mêlée with the Chinese vessels above Pagoda Point. These slipped their cables and bore themselves well. It is no longer at one, or even several cables length, it is at 100 metres, 50, finally at point blank, that they fight. Mortally injured by the torpedo of No. 46, the Yang-Woo, as we have stated, already makes for the shore. She receives several shell that hasten her loss. Our armed launches after having pursued vainly some of the enemy's torpedo launches, return towards the Chinese vessels; they surround the Foo-Poo, badly injured as is known by No. 45, carry her by boarding without much difficulty, and proceed to run her aground below the anchorage, where she fills. The alphabetical gunboats, Foo-Flug and Kien-Tching, tried to resist. Several well directed shell from our vessels promptly produce results. You see them from this moment straying as though infatuated about the battlefield.

All this took place in less than half an hour. The firing stopped almost entirely on both sides and the smoke dissipates. This is the spectacle the river presents; the war junks anchored between Pagoda Point and the arsenal are burning and sinking. The Volta's shells on the one side, those of the Duguay Trouin, the Villars and the d'Estaing on the other, have torn them to pieces, yet the brave crews of two or three of them still strive to resist. The two large junks anchored the other side of the river, and filled with soldiers with a view to attempt to board our vessels, struck by the shell of our gunboats, are afire. In a few minutes, as one might have expected, the three Chinese ships under the guns of our large cruisers were silenced. Set on fire by our shells, drifted by the ebb, they soon ran aground and sank some miles below. This is also the fate of the two alphabetical gunboats. The flames devoured the grounded Yang-Woo.

*Admiral Courbet's official report of the combats in the Min River.

As for the two transports secured to the arsenal quays, they were abandoned by their crews; the shells from our gunboats soon burn one and blow up the other. Two little Chinese vessels only, thanks to their light draught, are able to ascend the river and escape pursuit, but they bear on their sides serious injuries; they will not long delay running aground and filling.

The river is covered with men and wreck, 22 vessels destroyed, including the war junks, 5 captains that commanded the gunboats or the transports, 39 officers, and 2000 sailors or soldiers killed; these are the losses that this affair costs the Chinese navy. Ours are insignificant alongside such figures. Besides, they result more from the shore batteries than from the enemy's ships. Yet the guns of the latter handled by experienced men would have been formidable.

Thus, the effect of our fire was most astounding. To obtain this result our gunners pointed low. What above all strikes our officers when the smoke is dissipated? Plainly the water has swallowed up the hulls of several Chinese vessels, the very natural result of low-pointed fire, only with 14 c. guns against light hulls. But, at the same time, flames are rising all over the battlefield, showing that our shells set the upper-works of the enemy's vessels on fire with a rapidity, intensity and multiplicity of effect truly terrible. This is what struck our officers; almost astonished them. It furnishes a lesson not to be overlooked. Besides, it is a confirmation of the truth, proved already by several episodes of the American war of Secession, by the burning of the Schwartzenberg at Heligoland, of the Palestro at Lissa, that in presence of the effect of existing artillery, wood should be eradicated as quickly as possible from the construction of fighting ships. But this is not all.

Examine the results of some of the actions of the past 20 years. In spite of the advent of the ram and the torpedo, the gun still holds the first place in these actions. In what way does it principally make its action felt? Is it by causing at or near the water-line, breaches through which the water can enter and sink the enemy's ship? Very rarely, and only when the hull struck is light, like that of the Federal gunboat Hatteras sunk by the Alabama, or that of the same Alabama sunk later by the Kearsarge. No, when it is not fire, it is the injury caused the upper-works, the essential parts, the steering gear, the engine, the boilers, or the personnel itself of the attacked vessel, that nearly always shows the power of the gun. Why, during the war of Secession, was the ram Atlanta obliged to strike to the monitor

Weehawken, the ram Tennessee to surrender to Admiral Farragut's monitors and corvettes? Because the large 23 (9-inch), 28 (11-inch) and 38 (15-inch) c. smoothbores of the Federal ships pierced the armored redoubt of the Atlanta and destroyed the shelter of her pilots, carried away the smoke-pipe of the Tennessee, injured her rudder, and rendered many of their crews *hors de combat.* At the same time these vessels were in no danger of sinking. The same regarding the Huascar after her celebrated fight with the Cochrane and the Blanco. When the Peruvian vessel struck, her under-water body was intact, but her guns were dismounted, her turret ruined, the armor of her freeboard pierced and broken in many places; the Chilian shells had demolished the internal arrangements, had injured the steering apparatus, had killed nearly all the Huascar's officers, and had rendered half the crew *hors de combat.* And the Bouvet, after her encounter with the Meteor? And the Turkish ironclad Athar-Chefket, during her chase of the Russian steamer Vesta? It was projectiles striking above water certain badly protected parts of their evaporating apparatus, that robbed our vessel of all the benefits of a first success, that obliged the Ottoman to sheer off from an adversary over which she seemed to possess a crushing superiority of force.

Hence the terrible effect of our guns upon the Chinese ships during the Foo-Chow combat brings another proof in favor of this already demonstrated truth: that the gun is more to be feared for the injury it produces above water than for the possible destruction of "floatability." For this floatability is measured more to-day by the two new arms at the service of fighting ships: the ram and the torpedo. Against these the cuirass is absolutely powerless. Besides, this remains the only efficacious protection of the personnel of the ship above the water-line, of the guns, of the apparatus for discharging torpedoes, against the destruction by artillery and also against possible conflagration from shells. On the other hand, the floatability of a vessel has already obtained a partially efficacious protection, and probably each day will obtain more, against torpedo explosions, against the ram, and against artillery itself, in the multiplicity of water-tight bulkheads, and in a well-combined cellular or alveole system. The evident conclusion to be drawn from the preceding facts is that armor, still useful, and perhaps now more so than ever, to give to the upper parts of the real fighting ship—not absolute invulnerability, a desideratum impossible to realize—but a rational, efficacious

protection, at least, against light and medium calibres; armor should be abandoned from henceforth as a method of defence for squadron ships, at and below the water-line. We have seen this idea already put in practical use in the construction of several large foreign vessels, particularly of the Italia and of the Lepanto.*

V.

Up to this time we have only examined the acts of our squadron against the Chinese vessels stationed in the Min River. Their destruction was not the most delicate task imposed upon our ships. It was necessary that they should silence and dismantle, as much as possible, first, the batteries that protected the Foo-Chow arsenal, then in succession all the works echeloned along the river, which had to be descended for 12 miles. In two places the Min narrows so as not to be, between its banks, more than 400 or 500 metres (about 500 yards). These two passes, known by the names of Mingan and Kimpai, present certain difficulties of navigation, and are commanded by heights favorable for their defence. The Chinese had not neglected these advantages. Happily for us, the batteries they had erected, some time before our ships had entered the Min, were constructed more with the idea of repelling the attack of an ascending squadron. It resulted from this that vessels like ours descending it, were able almost always to station themselves so as to take the batteries in reverse or at least diagonally. After our arrival, the enemy, it is true, threw up new works and placed some new pieces in position. He did not have the time nor, perhaps, the means to create obstacles capable of stopping our naval force. Nevertheless, a numerous infantry was in readiness to sustain and protect the two passes. We shall have to settle with them when the time of attack comes.

The same day of the destruction of the Chinese vessels, August 23, our ships silenced the works defending the Foo-Chow arsenal. Only the Krupp battery in the Chinese camp upon a neighboring height had causedthem any loss or sensible damage. Next morning the arsenal was shelled by the Volta and the gunboats, as their draught would not permit the large cruisers to ascend the river thus far.

* See on this subject, *La Marine de guerre et son avenir, cuirassés et torpilleurs.* (The war navy and its future, ironclads and torpedo boats). By Mr. Grugeard, Ex-Minister of the Navy (pp. 46 and others).

"During the afternoon our 28 kilogramme (61.6 lbs.) shells demolished everything not beyond their reach. Fire directed upon the workshops and storehouses, and upon a cruiser under construction, did much harm, but not as much as I wished. With the 14 c. calibre nothing more could be done.

"The foundry, the fitting shop, the pattern shop are much injured; the hull of the cruiser is riddled everywhere, etc. But to destroy the arsenal, it was not sufficient to fire a lot of shell of the same calibre into it; the 24 c. (9.44 in.) or at least the 19 c. (7.45 in.) was needed, that is to say, it was necessary to bring the Triomphante or the Duguay-Trouin within range."*

Hence this is well understood. Simply to demolish an arsenal, knock down and burn its storehouses, its workshops, damage its docks, render its floating stock unfit for use, etc., even long ranged, small calibre guns are not sufficient, large calibre is necessary, "at least 19 c."

On the 25th our squadron begins the attack upon the Mingan pass. At this pass there is a series of works, of which the greater part, already noticed, fortunately can be taken in reverse or diagonally by our fire. Five or six of the Chinese batteries are casemated, one of them is armed with a 21 c. (8.26 in.) Armstrong gun enfilading the Mingan pass; another is armored with 15 thicknesses of sheet-iron, each 2 c. thick (total 11.81 in.), solidly bolted together. Plainly, 14 c. guns are powerless against such defences. Hence during the two days of our squadron's operations in the Mingan pass, the vessels thus armed (14 c.), protect our landing parties, throw shell among the Chinese infantry, finish the great task accomplished by the heavier calibres. Thus, to the Duguay-Trouin with her 19 c's, and to the Triomphante with her 24 c's, fell almost entirely the task of dismantling the Chinese batteries, and, in spite of the limited number of heavy guns these vessels carried, they acquitted themselves capitally.

The 27th, 28th and 29th of August, the same tactics against the Kimpai Pass. Here we find, among other works, two batteries of recently built 14 c. guns that enfiladed the pass, a battery armored with 15 c. plates and barbette guns, among which a 21 c. Krupp commanded the entire outside of the pass. While the vessels armed with the 14 c. guns covered the Chinese camps with shells, the Duguay-Trouin and the Triomphante, in spite of certain difficulties of

*Admiral Courbet's report.

navigation, due to their deep draught, silence and ruin the two 14 c. batteries, make large breaches in the ironclad work and in the casemated battery of Fort White, as well as dismount all the barbette guns in the vicinity, among them the 21 c. Krupp, finally protect the exit from the Min River of the rest of the squadron, by dismounting the last Chinese pieces that could disturb them.

Therefore, the indispensable services rendered during all these operations by the large calibres of the Duguay-Trouin and the Triomphante show out plainly in Admiral Courbet's so clear and so exact report. Without their assistance our vessels armed with the 14 c. gun would not have been able to demolish the Chinese works, would have suffered great loss passing their fire. Who can say that one of them at least might not have been rendered *hors de combat*, sunk or burnt after an injury to the engine that rendered her motionless under the enemy's guns? How has it been possible to invoke facts so clearly defined to assist this thesis: that gunboats, ships armed with small calibres and of light build, are capable of rendering the same service in similar operations as ironclads or cruisers carrying heavy guns?*

It is that people wish, systematically, to show the uselessness of ironclads, even for a coast war, and this is what is said: In the future they will avoid attacking batteries and the enemy's strong maritime places; they will reserve their ammunition to riddle with projectiles, open cities, commercial ports, undefended places.† Indeed, leaving out of the question every philanthropic consideration, nothing could be more dangerous than such a system of warfare; above all, against a neighboring power, at the same time continental and maritime. Suppose that even while master of the sea you are beaten on land, that your national soil is invaded. At the first hostile act against his commercial ports the enemy will retaliate by harsh and easily made reprisals, by pillaging and by burning those of your cities that he occupies, and by ruining everywhere your territory. And should he attack, by land, your strong coast defences, is it with unarmed gunboats carrying light-calibred guns that you will assist those besieged? Why, even a battery of field-pieces, sheltered behind an entrenchment, will suffice to keep these gunboats at a distance, whose too feeble projectiles, either near or at a distance, will have no effect, or but very little, upon the besiegers' parallels.

*Les torpilleurs autonomes et l'avenir de la marine. By M. Gabriel Charmes, p. 156. †*Id.*

The operations of the Rolf-Krake during the Duchies' war of 1864, on the other hand, give a fair idea of the services a small, light-draught ironclad can render in coast defence. Always isolated, and having only a battery of insufficient range and calibre—four 20 c. (7.87 in.) smoothbores—this little monitor was a continual thorn in the side to the German troops, who were compelled to construct batteries, establish stockades and lines of torpedoes, solely to guard against her. One saw, in spite of this, the Rolf-Krake now and then braving the concentrated fire of 20 or 30 siege guns, destroy bridges, sink boats full of troops, routing whole battalions, and thus contributing powerfully to the defence of Duppel. Can one think that even several unarmored gunboats could have performed similar service? The German artillery would have soon rendered them *hors de combat.*

Now, suppose that while master of the sea you are equally victorious on the land. Having nothing to fear from immediate reprisals, you bombard "open cities, commercial ports, undefended places," upon the enemy's coasts. Here there is no need of armor, but the same necessity exists for heavy guns, since they are indispensable to destroy "even workshops, storehouses, vessels building," or a fleet. This Admiral Courbet plainly has written, and doubtless no one will reject his testimony.

Really, will you be able to confine your maritime operations to this war of destruction that offers not the slightest danger to your ships? If your land forces besiege one of the enemy's military ports, defended by numerous and strong batteries, are these same vessels to remain as well calm as powerless spectators of the struggle? If by forcing a pass they can take in reverse works whose fire decimates and arrests your troops, will they neglect to aid them with a support possibly decisive?

The American war of Secession, and the Paraguayan war, present incessant examples of this precious co-operation of fleets with armies. But some will say, it was with wooden ships Admiral Farragut cleared the passes at New Orleans and at Vicksburg. Yes, in default of ironclads, corvettes and large gunboats, led by a chief whose talents approached to genius, were able to carry out brilliant strokes against works at the time incomplete and not of much account in comparison with the forts that to-day defend great military posts. Even then they were accomplished only at the cost of much injury and serious loss. At Port Hudson, Farragut was able to get only two ships past the Confederate batteries. The others were compelled

to retire and one of them was destroyed. The great work and the lengthy operations at Charleston, at Fort Fisher, at Mobile, and on the Mississippi, necessitated the employment of light draught ironclads, whose powerful artillery—generally 28 to 38 c. smothbores—fighting at close range, overturned the most solid of the enemy's fortifications and dismounted his guns. During the passage of an ironclad Brazilian squadron under the batteries of Humaita, a coast-guarder was struck by 96 projectiles and a little monitor of 340 tons by 200! Is it possible that light wooden ships, unarmored gunboats, could sustain such a hail of shot and shell without being reduced, burnt up or sunk? It did not require nearly as great a number of projectiles, and they only of 14 c., to destroy before the Foo-Chow arsenal not one or two ships, but the whole Chinese fleet. On the other hand, what would have become of our wooden vessels if, instead of attacking the badly defended works of Mingan and Kimpai in reverse, they had been compelled to engage in front and had found them manned with skilfull and brave artillerists? Even if they had been deprived of the assistance of the 19 and 24 c. guns of the Duguay-Trouin and of the Triomphante?

Hence heavy guns at short range—this fact is confirmed by all the Min River operations—are as necessary to reduce good fortifications seriously defended, as to destroy an arsenal; and these heavy guns cannot act with security under the required conditions, unless the vessels carrying them, of a relatively light draught, are, above all, protected by suitable armor against the enemy's fire.

VI.

We have seen that, on the 23d of August, the destruction of the Chinese fleet was not accomplished without an effort on the part of the land batteries in the neighborhood of the Foo-Chow arsenal and of Pagoda Point to oppose it. From this time also our adversary's infantry shows itself disposed to do what is incumbent upon it in the struggle. At different times our little vessels are worried by its fire, particularly the gunboat Vipère, which approached the arsenal to destroy the floating stock. Welcomed at first by a shower of balls, very badly aimed, and fired by Chinese hidden in rifle-pits, she is next fired upon at 300 metres by soldiers that advanced bravely to the edge of the quays. To the volleys of our musketry the enemy replied by firing at the word of command,

leaving numerous traces of bullets upon the Vipère's hull. Happily, the captains of our vessels have taken care to protect their crews against such attacks by shelters of various kinds: bullet screens, armor of light chains, etc. These simple precautions will save more than one man's life.

As our squadron, successively taking the Chinese batteries in reverse, chased the defenders from one or another series of works, it became necessary to render the abandoned cannon useless, so as to prevent the enemy from remounting them when our ships would pass from before them, still bent upon the work of destruction upon which we counted to make the Pekin cabinet accept our conditions. Upon the sailors of the torpedo squad, protected by the landing parties and covered by the fire of our ships, fell the duty of accomplishing this. Here is shown the true role of gunboats in such expeditions; not to engage in battle—sterile as well at long range as at close quarters, and very dangerous for them in the latter case—against solid, permanent fortifications covered with guns, but to aid by every means in their power the doings of the forces operating on shore. Thanks to their light draught, they will be able to approach close to shore, to pass over or to stop upon shoals to which access is interdicted to heavier ships. They will protect all the movements of our armed boats, will cover as well the offensive march as the retreat of our disembarked sailors. With their 10 c. (3.94 in.) and 14 c. shell they will beat up all the lurking places, will worry the Chinese in their camps and behind their entrenchments; when the latter show themselves they will disperse them, or at least hold them at a respectful distance by means of musketry and Hotchkiss fire.

This also was the principal sort of service that, on a much larger scale, the gunboats often rendered the Federal armies during the war of Secession. One saw them on every river and in the shallow waters of certain Atlantic bays, covering the debarkation, the passage, the advance or the retreat of the land forces. At the big battles of Pittsburg Landing, Williamsburg and Malvern Hill, they either averted a Federal disaster or powerfully contributed to their final success by raining shell upon the enemy's columns.

Let us return to the operations of our squadron in the Min River. We now have to describe the destruction of the guns the Chinese have abandoned in the works successfully silenced by the guns of our cruisers, above all by the heavy guns of the Duguay-Trouin and of the Triomphante. Compelled to retain on board, particularly on the

gunboats, a large part of the crew, in order to be prepared for any emergency, the Admiral, as we have said already, only had available for this service a few hundred sailors. Full of good will and dash, the greater part of these brave fellows had never been employed in an expedition, and therefore could not possess, for this kind of work, either the experience or the solidity of old soldiers. To this cause of relative inferiority is added another of an entirely physiological order, independent as well of men's moral qualities as of their military instruction.

Should you remain, for example, a year aboard ship, then go ashore—on an unknown shore—in a broken country, from the very beginning you will feel as though dazed, your feet hardly will seem to be on solid ground, you almost will hesitate at obstacles formerly easily cleared, but of which, so to speak, you have no longer an idea—the smallest ditch, a slope, a thicket, etc.; your eyes will be astonished to see certain things formerly entirely familiar; finally—the most important detail in a case like the one now before us—*you will judge distances in a most completely inexact manner, no matter how well versed you may have been in this exercise before you went on ship-board.* These physical sensations which have just been summarily described have been experienced without doubt by every seafaring man, whether officer or sailor, after a long cruise. We are convinced they have had their influence on certain checks experienced under various circumstances, by disembarked sailors.

With his great prudence, his correct and firm judgment, Admiral Courbet took good care not to expose his feeble companies to such a misadventure, by throwing them forward through an unexplored country, away from the view or out of the range of his ships, against an enemy ten times superior in number and well entrenched. He is satisfied to send them ashore singly or by twos, under the protection of the fire of our ships and of our armed boats, to sustain the little squads of torpedo workers who were to burst the Chinese guns with gun-cotton. At each place, as soon as this duty is performed, our detachments return aboard as quickly as possible.

In this way, from the 25th of August, the landing parties carry off and bring aboard three small calibre Krupps, the torpedo corps destroyed the large 21 c. Armstrong which not long since enfiladed the Mingan Pass, all without serious opposition from the Chinese. On the 26th and the morning of the 27th are destroyed all the guns in the batteries of the Mingan Pass, with the same success and the same impunity.

A more energetic resistance met our ships, armed boats, and our landing parties above the Kimpai Pass. It was evidently in this channel, about 400 metres broad, still further narrowed by dangerous shoals, that the enemy expected to stop the exit of our squadron. Without taking into account the other artificial obstacles here accumulated, the Chinese had gathered numerous infantry.

"They wish, above all, to fight us with volleys. And really the natural configuration of the locality and the works they have executed here, greatly favored them in this funnel-shaped place. Upon the right bank crenated earthen walls and houses half way up gave them shelter; on the left bank brushwood, then a heavy dam, and finally the village of Fort White."*

It was necessary, above all, to destroy a large number of junks loaded with stones, ranged along the right bank, intended by the Chinese to block the pass. The evening of the 29th our gunboats support the boats detailed for this operation, which accomplished it capitally, though not without loss. Covered by a ridge on the left bank, some Chinese skirmishers annoy the gunboats Vipère and Aspic. In spite of the distance, about 1200 metres (1300 yds.), their bullets often struck. Two volleys of musketry from our little vessels and the accurate fire of the Hotchkiss compel them to retreat. From the right bank, however, come more dangerous attacks. Completely hidden behind the crenated wall that followed the ridge of a hill running from the river to the top of the heights, the Chinese skirmishers open fire upon our small boats and gunboats. The latter are obliged to shift anchorage and to approach nearer to the left bank so as to obtain diagonal fire upon the crenated wall.† Fortunately, our boats accomplish their object and in their turn retire.

The 28th, the operations against the defences of the Kimpai Pass are continued. The 14 c. guns and the cruisers' Hotchkiss once more dislodged the Chinese skirmishers from their shelter on both sides of the river; our shell explode a magazine and set the village of Fort White on fire. On the left bank, detachments thrown ashore destroy some guns, but run great danger; the points of landing are

*Admiral Courbet's report.

† It was while the Vipère was getting under way that a bullet mortally wounded Lieutenant Bruët-Villaumez, who on the poop of this little vessel was directing at the time the fire of the Hotchkiss guns. This valiant officer fell, a smile on his lips. Feeling himself fainting, "Carry me away," said he simply to the sailors stationed near him. He died without having recovered consciousness.

covered with electric torpedoes, and the enemy's skirmishers occupy excellent positions from which the fire of the ships cannot dislodge them altogether. Our men return aboard without succeeding in completing their work of destruction.

The same difficulties, only greater, on the right bank. Our landing parties are compelled to fight retreating before forces numerically overwhelming, and suffer sensible loss. Commandant Sango, chief of the expedition, is wounded. Two officers and eight men are unable to get off, but find cover behind a grounded steamer near by. Now it is that the utility of gunboats, of light draught vessels, makes itself felt in all its force. The Admiral sends the Aspic and the Lynx to anchor towards the eastward, a short distance from shore, so as to enfilade the valley leading to the fort, from which the Chinese descended; "under this protection, an armed boat rescued without a blow and brought aboard those left behind."*

It is easy now to take note of the important and decisive role, filled during this series of small descents, not only by the 14 c. and 10 c. guns, but also by the Hotchkiss and by the muskets of both gunboats and cruisers. No doubt the useful employment has been remarked, under different circumstances, and even aboard our ships, of musketry volley-firing. "This kind of firing cannot be too highly recommended, because you retain your men under some sort of control. Thus, they are compelled really to sight. They uncover to fire, but they fire coolly and with confidence. After the third or fourth volley the most timid act like the bravest." †

VII.

It remains for us to specify the services of the very first order rendered during all the operations on the Min River by the armed boats, and particularly by the steam launches of our squadron. Already we have seen the latter ready at need to protect the gunboats and the cruisers against the attacks of the Chinese torpedo boats. It is useless to insist again upon the importance of this. As we have already stated, a short time afterwards, some of these same steam launches carried the Chinese cruiser Foo-Poo by boarding, after she had been struck by the torpedo boat No. 45. An unforeseen episode of the struggle, without doubt due to the inspiration of the brilliant officer commanding our boats, taking place, however,

*Admiral Courbet's report. †Report of the captain of the Vipère.

under circumstances exceptionally favorable to success, such a fact should not be allowed to produce any illusion.

Formerly when in a calm, the sails, the only motive power of the vessel, hung inert along the masts, many times boats filled with armed men, in broad daylight and upon open water, have been enabled to obtain possession of a ship, even of some force and well defended. Steam, for some years past, has rendered such bold strokes almost impossible, even for boats themselves also possessed of this means of locomotion. February 19th, 1868, at the time of the passage of a Brazilian squadron under the batteries of Humaita, some Paraguayan soldiers in about twenty ordinary flat-boats attempted to board the little monitor Alagoas, which, some distance behind the other vessels, was with difficulty ascending the river. This effort failed. Three of the Paraguayan boats were sunk by the ram of the Alagoas, three others by her grape.

The carrying by surprise, during night or fog, of a vessel at anchor, is the only operation of this sort since the application of steam to navigation, that seems to present possible chances of success. It was thus during the night of March 1st–2d, 1868, near Humaita, that some thirty Paraguayan row-boats, secured two and two and each carrying 25 men, boarded the Brazilian coast defence ironclad Lima-Barros. This time again the assailants were repulsed. During the War of Secession, Confederate boats, more successful, carried two Federal gunboats by boarding, the Underwriter and the Water-witch, at anchor, the one in the River Neuse, the other in Assabaw sound.

But to-day, with revolving cannon and the photo-electric apparatus of which ships make use for their defence, can such efforts have the same chances of success? Evidently not. It generally will be found much surer to attempt the destruction of a hostile ship by means of torpedo boats than to confide the almost impossible task of her capture to armed boats.

Hence, the carrying by boarding of the Foo-Poo by some of our boats should be regarded as an exceptional, almost an abnormal incident. But this feat of arms does not limit the doings of our steam launches during the 23d of August. After having rendered unfit for service several Chinese torpedo launches, they destroy in the custom-house arroyo junks and sampans, without doubt destined for fire-ships. Next day they display the same activity. While some finish clearing the custom-house arroyo, the others, under the protection of the Volta and the gunboats, destroy the fire-ships and the floating material collected above the arsenal.

After the morning of the 25th a not less important, and perhaps more delicate task is imposed upon our armed boats: that of landing, of seconding and of covering the squads charged, at many different and numerous points, with the task of rendering the Chinese guns unserviceable. These operations, often interfered with by the strong current, continued until the 28th and gave rise to several lively skirmishes.

While the greater part of our squadron was fighting at Pagoda Point and in the Mingan Pass, the Chateau-Renault and the Saone were detailed to prevent the obstruction of the Kimpai Pass by the Chinese. Their boats accomplished the most arduous portion of this duty by the incessant vigilance they exercised during the night. When the Admiral anchored above Kimpai the 27th of August, it was these same boats that destroyed, under the protection of our gunboats, the junks loaded with stones by the enemy with the intention of sinking them in the Pass.

Finally, as a last obstacle, the evening of the 28th, our squadron find the narrowest part of the channel barred by a line of rafts. The pilots declare these rafts sustain electric torpedoes. During the course of the following night our boats drag the Pass carefully, visit the rafts and satisfy themselves that the information given by the pilots was erroneous.

Such is the long list of the multiplied services rendered by the armed boats during the continuance of the operations in the Min River. Here certainly is matter for reflection. If a division of torpedo boats is to-day one of the indispensable elements of any naval force operating upon a hostile coast, should not one say the same respecting steam launches that tow, transport, shoot, penetrate everywhere and destroy the material that the vessels' shells cannot reach? Referring to the debarkation of one of the detachments detailed to break up the Chinese cannon, Admiral Courbet notices in his report that "the current rendered the transportation of these people very difficult." In many cases, the speed of our steam launches as well as their power of traction seemed to be altogether insufficient. For operations like those in the Min River, boats as speedy as torpedo boats, but very different from them, are needed, very much shorter, easily shipped, easily managed, of light draught, capable of running anywhere, and of receiving a good armament. That is to say that the type of "fighting steam launch," capable of aiding the "counter torpedo boat," or of taking its place to a certain extent during the absence of the latter, is yet to be devised.

VIII.

When one reads attentively Admiral Courbet's report on the Min River fights, one thing more perhaps than anything else strikes one—the enormity of the task accomplished from the 22d to the 29th of August by the 1800 sailors of our squadron, and the amount of perilous hard work endured by this handful of men in such a short space of time. They were, indeed, at the extremity of an impassable road, before a hostile arsenal, surrounded by men-of-war, fire-ships, torpedo launches, batteries and armed men; having behind them a narrow channel 12 miles long, lined with other batteries, commanded by heights where were encamped soldiers ten times their superior in point of numbers, and terminating in a much narrower funnel-shaped mouth, for the closing of which their adversaries had prepared everything. Well! After six days not only had our little squadron come forth safe and sound from this impassable barrier, but it had destroyed nearly everything; arsenal, men-of-war, fire-ships, torpedo launches, barriers, cannon of the batteries. The struggle carried on by it comprehended all kinds of operations likely to be undertaken by a number of men-of-war: naval action, with cannon, torpedoes and with muskets; boarding a vessel from boats; defence against fire-ships and torpedo launches; bombardment of an arsenal; fights against batteries and against infantry; debarkations; shore fights; destruction of barriers, and dragging of a Pass—nothing is wanting.

Another thing, and this entirely to the honor of the chief of our squadron, is shown equally from reading his report. If there be a principle daily applicable to the operations of a war navy, it is that which consists in claiming from each type of ship, from each kind of arm, from each category of men, everything, absolutely everything possible, but nothing more. Thus it is easy to see that during the Min River fights this principle never was departed from. Truly, it would have been very difficult to have required from our sailors, from our vessels and our boats, from their cannon, from their torpedoes and their muskets, more energetic or prompter services. On the other hand, measuring with a clear view the advantages to obtain and their cost, the Admiral guarded against every foolhardy enterprise, against all dangerous stubbornness. When he has found that our 28 kilogramme shells can not ruin the arsenal, he draws off, reserving his ammunition for a more essential work; when he judges that his landing parties will not succeed in destroying certain

cannon on the left bank of the river, without considerable loss, he does not hesitate to recall them. It is thus that a chief acquires the right to expect everything possible from his subordinates; it is thus that are produced, almost naturally, results that one could hardly count upon.

If one will place one's self at this point of view, the Min River fights will be highly interesting. Have we reached the point where we can show that one also can gather precepts of another sort? We leave it to the reader to answer. But we wish, above all, that he will not be able to give a false or exaggerated interpretation to our reflections, and for this we undertake to close our labor with a few lines which will perhaps throw a little light upon the subject.

We are a firm believer in the power of the offensive torpedo as a weapon of fighting boats. To this several of our studies previously published in the *Revue Maritime et Coloniale* will bear testimony. The Whitehead torpedo seems to us to be excellent for swift boats under certain circumstances, but not under all. Hence we are doubly joyful over the brilliant success of Nos. 45 and 46 at the Foo-Chow fight. May this success bring back attention, and some favor, to the modest spar torpedo, already old, with which nobody any more concerns himself; truly only too much despised in spite of the services it has rendered!

We are a believer in the power of the torpedo boat, not less than in that of her torpedo. But this power has limits drawn by the dimensions, the provisioning, the nautical qualities, the *habitability* and the vulnerability—in a word, by the very nature of the boat. To imagine that because two torpedo boats of 50 tons—rather large, we wish it understood—made, with or without the squadron of evolutions, several fortunate passages in the Mediterranean, to imagine that boats like these will be able to vanquish and to replace large men-of-war upon the ocean is an illusion of the most dangerous kind.

Still another illusion, and also a very dangerous one, is to believe that the electric light and revolving cannons when available to her adversary, are means of defence that a torpedo boat can despise. Equally upon this subject we have had the satisfaction to find amidst the muliplicity of operations performed in the Min River a fact coming to the support of our ideas. Far be it from us, though, to seek there for an argument against the introduction, each day more extensive, also each day more logical, of torpedo boats amongst the

elements of coast defence or coast attack. We simply wish to place before all this opinion against too absolute formulæ, like the following: "A squadron attacked at night by torpedo boats is a squadron lost."* No, indeed, it will not be lost, no matter what may be the number of its adversaries, if it is properly armed and lighted, protected at its anchorage by exterior defences appropriate to the circumstances, guarded by swift counter-torpedo boats and other steam launches, if its personnel is brave, exercised and kept strictly vigilant.

We think that unarmored vessels, carrying medium calibre guns, and whose light draught has been sacrificed to speed or the reverse, following the duties they have to perform—we think such vessels will be indispensable to a large navy. But we are certain—and the Min River fights, after many others, confirm our opinion—that large calibres are necessary, particularly for coast wars.

Finally, we think that if it were possible from this time forth to remove the armor belt from the line of flotation, by means of the protection given to the underwater body of a fighting ship by a well-conceived cellular or alveolate system, the cuirass will still remain the only efficacious defence of the upper works against the terrible effects of modern artillery.

Above all, one must be upon one's guard against rejecting as useless this costly floating material which, in spite of all that may be said, has proved its worth under many circumstances during the American war of Secession, in Paraguay, at Lissa, and upon the coasts of Chili and Peru. The torpedo, no more than formerly the ram, has not yet "virtually killed armor";† while a fighting ship possesses a solid hull and a good engine she can render useful service. The wooden ships of Farragut in America, of Tegethoff at Lissa, of Courbet in the Min, triumphed brilliantly over obstacles which they hardly seemed fit to surmount. Our old ironclads, led by chiefs of this kind of valor, would know even yet how to make light of cannon, or of ram, in a way to disconcert an enemy that should have committed the imprudence of despising them.

*Automatic torpedo boats and the future of the Navy. By M. Gabriel Charmes, p. 130.

†*Id.* p. 163.

ON THE COMBUSTION OF GUNPOWDER IN GUNS.

By Lieut. J. F. Meigs, U. S. N.

The object of this paper is to present what seems to be a reasonable explanation of what are commonly called "wave pressures" in guns. When charges of powder are fired under certain conditions of loading, the readings of pressure gauges placed in different parts of the chamber differ very sensibly; and the pressure to be anticipated, instead of being capable of being predicted with reasonably accuracy, seems capricious and unfettered by law. It appears that the cause of these effects, though they are in different cases apparently due to very different causes, may all be ascribed to the powder being placed in bad geometrical conditions as to its lighting and burning.

It is necessary to note in the first place that the pressure depends very intimately upon what the French call the density of loading, which is the weight in unit volume of the powder in the charge form. If the weight of powder in a fixed volume be large, obviously the pressure will be high, and *vice versa*. Before a charge is lighted, the density of loading is the same throughout its volume; but if by any cause, as by an irregular formation of gas at different points of the charge, it be deformed and pressed violently, the density of loading at the instant of burning of any part may become variable, and may be very high at some points.

If we conceive a very large sphere of grains of gunpowder—the sphere being so large that the dimensions of the grains may be neglected when compared with its own—to be lighted at its centre, it is evident that the parts just lighting will at any instant lie on a spherical surface whose centre is the point of ignition. If we pass in along a radius of this surface, we shall pass through regions in which the pressure is higher and higher, and in which the heated gas is moving outwards through the interstices of the portions of the

grains which are still unburned at high velocities. If now we conceive a cylinder of some unyielding substance to be passed through the sphere of grains of powder, with its axis passing through the centre of the sphere, it is evident that we shall alter the circumstances of burning. The lighting surface will still be a sphere until it touches the cylinder; but at that instant, since the directions in which the gas already formed may escape become limited, the velocities of flow in the available directions must increase. Further, as the radius of the unyielding cylinder contracts, the conditions favoring the equalization of pressure become worse, until, by the contraction of the cylinder's radius, the powder to be burned becomes a long thin cylinder. When, further, we conceive an unyielding diaphragm to pass through the cylinder at the point of ignition, we have nearly the conditions of burning of a long thin charge.

In a very lucid and admirable paper on the "Heavy Guns of 1884," read at the Royal United Service Institution on June 20, 1884, Colonel Maitland states the following:

"The principle of chambering, that is, of enlarging that part of the bore which contains the explosive, depends upon a peculiarity in the action of powder charges which is not very generally known or understood. I will endeavor to make the facts clear to you. Supposing I fill a chamber which measures 1.15 in. in diameter and 18.6 in. in length with R.L.G.^{2} powder, at a density* of 35.6 cubic inches per lb., as in the proof charge of the 12-pounder muzzle-loading field gun; the pressure will be extremely capricious, varying from about 26 tons to 37½ tons per square inch; the velocities will vary also, but to nothing like the same extent. Next, supposing I fill a chamber which measures 7 in. in diameter and 18.6 in. in length with 20 lbs. 3 ozs. of R.L.G.^{2}, at the same density as before, as in the 7 in. muzzle-loading gun; I shall get fairly regular pressures and velocities; the pressures will be about 22 tons only, varying about a ton above and below, although the densities of the charges are equal, and there is more than five times as much powder in the charge which gives the lower pressure. This anomalous result arises from the shape of the chamber. It is found that long narrow chambers favor the development of 'wave pressures,' as they are called, in a surprising degree, and experience has clearly shown that to get the best effect out of the charge, the

* For definitions of the term *density of charge*, as well as density of loading, see Text Book of Ordnance and Gunnery, published at the Naval Academy, 1884.

chamber should not be longer than from three to four times its diameter; with a powder which is slow in proportion to the size of the gun, it is generally safe to approach four diameters in length; but with a powder quick in proportion to the size of the gun, it is often dangerous to exceed three diameters in length. The cause appears to be that as soon as the charge is lighted the gas first evolved travels through the chamber from end to end with great rapidity, and sets up a dynamic action of a vibratory or wave character.

"But if it is asked why increasing the diameter of the chamber should mitigate and indeed remove this action, I have to confess frankly that I do not know. In the cases given the gas has just as far to travel, and to acquire momentum in, but it seems to lose the intensity of its rush from end to end when afforded increased space laterally. Many efforts have been made to overcome this difficulty, and to obtain satisfactory combustion in long narrow chambers by means of extensive air spacing, or by introducing central tubes of zinc and other substances; but the results have not been very promising, and in the Royal Gun Factory we have kept all our chambers short and thick, so as to consume the charges under the most favorable conditions."

The violent motion of the gas which is here described no doubt takes place; but it is the *effect* and not the *cause* of the differences of pressures as registered by the gauges.

The experiment which Colonel Maitland cites is very apt, and seems to present the solution which he seeks. In the two cylinders, if they were each lighted all over their cross section at either end, their conditions of lighting and burning would be absolutely identical. For we may conceive the larger cylinder to be made up of a number of the smaller ones; and the reasonable assumption that the dimensions of the grains are small when compared with those of their containing envelopes being again made, it is apparent that each of the smaller cylinders will light and burn along their length precisely as though they were held in an unyielding envelope.

If, however, each of the two cylinders were lighted at a point, as was undoubtedly the case (though this statement is not made), then the conditions for the approximate equalization of density of loading and of pressure in the small cylinder are evidently much less favorable than in the large one. The surface which is just lighting in the former will very soon be a right section of it; while in the latter this surface will be nearly a hemisphere, and will approach a right section of the cylinder only after the lapse of a longer time.

It is clear also that anything which favors the rapid formation of gas will tend to produce inequalities of density of loading at the instant of burning. So that although we may find in any chamber that the pressure is tractable under certain conditions, yet we can by no means infer that this will still be the case with a quicker powder.

A large value of the ratio $\frac{\text{length of chamber}}{\text{diameter of chamber}}$ appears then, in the conditions of lighting universally adopted, to be an unremovable cause of inequality and violence of pressure in the chambers of guns; and, as is well known, in order to keep this ratio within certain limits, the increasing of the diameters of powder chambers, with all its attendant evils, has been resorted to. If by any expedient in lighting the charge at many points and yet delaying its action somewhat so that the shot could get away before the whole charge is burned, this evil can be removed, a great improvement will be made.

It is interesting to examine what might be the probable effect of lighting the charge axially at its front end. In this case, since the shot moves more readily than the gun, it appears at first sight as though the conditions as to pressure might improve over the rear ignition, as parts of the gas formed would expand in the direction in which the shot is moving; but the parts of the charge which would burn when their density of loading was high would, in this case, be those near the breech plug, and it appears reasonable, therefore, to regard this method of ignition with distrust.

NAVAL INSTITUTE, WASHINGTON BRANCH,

JANUARY 3, 1885.

COMMANDER C. F. GOODRICH, U. S. N., IN THE CHAIR.

MŒRIS: THE GREAT RESERVOIR OF MIDDLE EGYPT.*

WITH THE TOPOGRAPHY AND CONSTRUCTION OF THE PYRAMIDS.

BY COPE WHITEHOUSE, M. A.

Top of Second Pyramid, 642.9
Top of Great Pyramid, 612.10

Top of Third Pyramid, 406.8

Top of Hill, . . 250.0

Base of Third Pyramid, 203.8
Base of Second Pyramid, 195.3
Base of Great Pyramid, 162.1

Head of Sphinx, . . 80.0

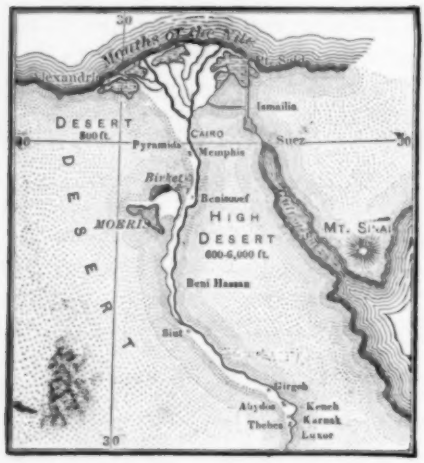
Excavated Chamber, . 60.0
Sand plain at Base, . 33.8
High Nile of 1838, . 24.8
Low Nile of 1838, . . 0.0

THE PYRAMID-HILL OF GIZEH FROM THE EAST.

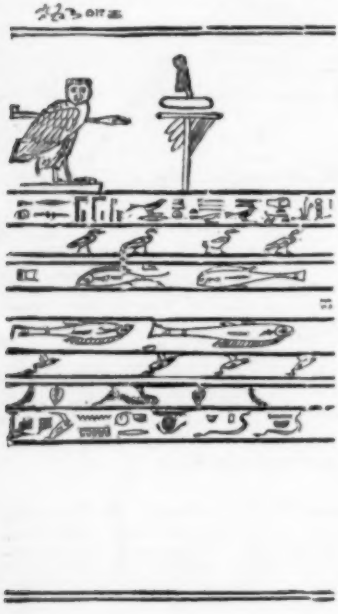
The maps of Egypt prior to the publication of my researches in October, 1882, represent the desert to the southwest of Benisuef as an elevated plateau. The map of the French Expedition, following D'Anville, supported by the obser-

* A brief summary of the lecturer's remarks.

vations of MM. Jomard and Martin (Jan. 29th, 1799), indicate a *Grande Butte Pyramidale*, called the Heram Medaie el-Hebgad, 14 kilometres to the southwest of the Quasr Qeroun, a temple in the Desert at the southwest extremity of the Birket or Lake el-Qeroun. On the map of M. Linant de Bellefonds there are ridges suggested by shading of color, but in an extremely vague manner. At the meeting of the British Association at York (1881), I had shown that the ancient writers agreed in describing a vast impounding reservoir in Middle Egypt, to the southwest of Memphis, 450 miles in circumference and with a depth of 300 feet below high Nile. The account was so circumstantial in its description of a lake, blue in color, with twenty sorts of fish; its shores occupied by multitudes of fishermen engaged in catching and salting the fish, while the upper plateau was correspondingly fertile.

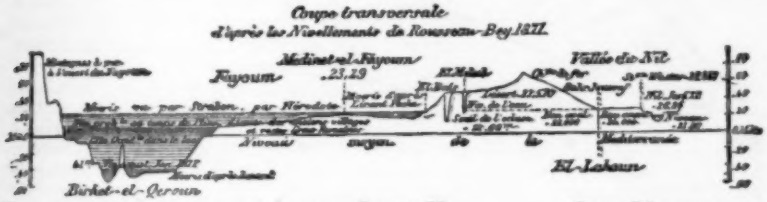


MAP OF EGYPT WITH LAKE MŒRIS RESTORED.

The products of its fields were the best crops of Egypt. Its borders were lined with terraces of vines and olive trees, while broad stretches of pasturage enabled the government to support the flocks and herds of the State during high Nile without the expense of storing grass or the necessity of driving them to the Oases. The existence of this lake was denied. In 1840 M. Linant had suggested an alternative which had been universally adopted and supported by a large body of evidence. It had even obtained the endorsement of such a competent observer as M. Mariette, who with Dr. Brugsch interpreted a papyrus map as proof conclusive that the theory of M. Linant was correct. On this papyrus, however, it will be observed that there is no line of conventional leaves representing vegetation, on the upper or western side of the Lake. This was attributed to a mistake of the cartographer. Such an error was scarcely credible. If it was not an error, then it was a conclusive proof that Lake Mœris lay under the western hills of the desert, where the Birket still continues to receive the water of the Bahr Jousuf; and not on the upper plateau between the Birket and the hills which separate the Fayoum from the Valley of the Nile.

The section of the Fayoum as given by Dr. Lepsius is so plainly opposed to natural laws that it inspired no confidence. A bank of alluvial deposit could not have been formed as is represented, nor was it fair to measure the length of the reservoir which would be formed by converting a defile into a lake as equal to the length of the stream which meanders through it.

ERRONEOUS SECTION OF LINANT DE BELLEFONDS.

Dr. George Schweinfurth had already published a map which showed that this section was hopelessly bad, and that the depth of the western depression was precisely the 250–300 feet given by the ancient historians. Even the latest geographers and cartographers had neglected this map. It was unknown to me

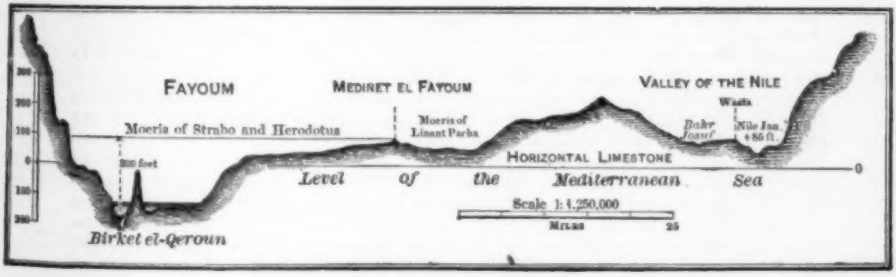


FROM THE REVUE ARCHEOLOGIQUE, JUIN, 1882. COPE WHITEHOUSE

until after I had reached the same conclusion independently. Schweinfurth's facts were verified by me also from the field-book of M. Kruger, lent to me by Rousseau Pasha (April 21st, 1882), from which I transcribe as follows:

De Medinet au Birket Quaroun (*sic*) + 23.290. Seuil de la porte d'entrée du Palais du vice-roi à Medinet + 23.000. Repère sur pont du Bahar Senhour +22.640;—17.463;—20.281;—22.949;—41.701. Eau amont à Ellahoun [Nile Valley] +24.694. Medinet audessus de la mer, + 23.290. Birket, — 39.705.

There is not the slightest doubt of the substantial accuracy of these figures, and an error of fifty feet would not affect the issue. A section through the Fayoum is, in effect, a complete justification of Herodotus and affords a most astounding example of human error.



SECTION THROUGH THE FAYOUM.

M. Jomard, although knowing that the depth had been fixed by all the ancient authors at between 250 and 300 feet, estimated it at between 20 and 24 feet (*six à sept mètres*), and M. Linant, correcting him, averred that the depth of 100 feet (32 metres) was the result of a line of levels actually run by him when Director-General of Public Works.

It was necessary for me, however, to find a depression, equal in depth, to the south of the Fayoum. The existence of a *Grande Butte* confirmed me in the belief that there must be a corresponding erosion. The hills of the Libyan Desert are the remains of eroded strata, which assume a pyramidal form. The word Haram means pyramid. The Egyptians, however, never employ it in a general way, but confine it to these structures between the Mœris Basin and the Nile which are not all of them pyramidal.

PYRAMIDAL HILL IN THE DESERT. Long. 30° 55′.

An island with pyramidal summits once stood, according to the ancient historians, in the middle of Lake Mœris. Therefore, the Haram might, I assumed, prove to be the island. No other traveller had cared to venture into its inhospitable neighborhood. On the 3d of March, 1882, I satisfied myself that it was in a deep erosion. On the 3d, 4th, and 5th of April I ran a line of levels (for which I am indebted to my companion, Mr. Flinders Petrie), from the Fayoum to the eastern part of the same basin. Assuming Medinet to be +75 feet, the Wadi, or valley, sinks to —175, and the shore of the former lake is plainly marked beneath a commanding space of limestone, known as the Hagar Musqiqeh.

It seemed to me, from a careful collation of a large number of manuscript maps attached to the text of Claudius Ptolemy, that in the later period, after the drainage and irrigation canals of lower Egypt were in working order, and the cultivation of the land had been extended to the very edge of the Mediterranean and Mareotis, Bourlos and Menzaleh, with diminished area, had been converted into fresh water lakes, the great reservoir had been reduced to the Southern Basin, now known as Wadi Reian. I am well aware of the extreme importance as well as the apparent temerity in thus venturing to differ from all other students of ancient cartography. At all events it induced me on the 17th of March, 1883, with an Italian engineer of experience, detailed for this duty by the Cadastre, to run a line of levels fron the N. E. corner of Qasr Qerun to the surface of the lake. It is true that the canal which supplies this fortress and town was fed by a natural flow from the Nile, but it is equally certain that the limestone ridge which separates the Qerun from the Reian Basin is sufficient to confine the water in the southern part. Therefore the partial restoration of Lake Mœris is possible without any expropriation of cultivable land in the Fayoum. Whatever is done in the southern valley must

be wholly beneficial. The extent of the restoration would necessarily determine the mode of introducing the water. Drainage canals are as essential as irrigation canals. The waste water which is now turned into the Bahr Jousuf pours into the Birket Qeroun. But evaporation, since the opening of Ibrahimiyeh Canal, has not been sufficient to keep the lake at its former level. It would be a task of insignificant expense to reopen an old channel through drifted sand between the Charaq and Reian Basins. In that event cultivable land would be recovered on the shores of the northern lake, but the southern would only add extensive and valuable pasturages, or yield a single and precarious crop. No engineer would be content with this result, except as a step towards the completion of an impounding reservoir. But even this relief might aid the various enterprizes which have been proposed for the redemption of the lagoons of the coast. A more effective way would be by a channel direct from Behnesa across the desert, a distance of probably ten miles. The armorial bearings of this town—the Phœnix—have been preserved with the name for perhaps 3000 years. The appellation is peculiarly appropriate if a canal once led through the arid waste into the blue lake beyond. A hieroglyphic description definitely states that a canal of about 60 feet once conducted the water of the inundation towards the "Mœris of the West." In general, therefore, it is sufficient to show that the Egyptians, or more probably that invading race which seems to have anticipated the history of the Spaniards and Moors, had utilized this remarkable feature in the topography of Egypt, and that what they did could be repeated at infinitely less cost. The work to be done is that which has already been accomplished. Success is assured. The labors of these ancient engineers are still in some measure available here, as M. de Lesseps used the work of Nectis in the Fresh-Water canal.

The outcome of the scheme proposed is thus summarized in the *Century Magazine* for October last:

"The conclusion of Mr. Whitehouse's labor, then, seems to be that a basin exists of sufficient depth and other dimensions,—a basin worthless for all other purposes than those of storage,—situated near the Nile, and easily connected with it by a comparatively inexpensive canal, already once dug and still visible in parts, and utilized in long sections; that this must have formed the southern part of the ancient Lake Mœris of Herodotus and Strabo; that, if this part only were restored, it would hold in storage, to be made useful in irrigation, if necessary, all the waste waters of the overgrown and much dreaded Nile floods; that, if so used, the Berket-el-Qeroun, which since the opening of the Ibrahimich Canal has encroached on the tillable soil, could be reduced to one-half its present size, and thus many thousand acres of good land be restored to its borders," etc.

A scheme so easy in its execution, and so wide-reaching in its beneficial effects, is certainly deserving of the serious consideration of all interested in engineering works, in the general question of the improvement of the conditions of human life, or in its special development in that wonderful region—ever old and ever new—the Land of Egypt.

PROFESSIONAL NOTES.

TESTS OF ANTI-CORROSIVE ANTI-FOULING COMPOSITIONS FOR THE BOTTOMS OF STEEL SHIPS.

MADE BY THE NAVY DEPARTMENT UNDER THE DIRECTION OF THE NAVAL ADVISORY BOARD.

BY LIEUTENANT-COMMANDER F. M. BARBER, U. S. N.

The importance of protecting the bottoms of iron and steel ships from corrosion and fouling cannot be overestimated. Corrosion involves the life of the ship, and fouling involves the speed and consequent economy of maintenance. Generally speaking, two methods are resorted to for obtaining the desired result.

First.—Sheathing the bottom with wood, covered by copper or zinc. *Second.*—Covering the bottom with paint. The first method requires the stem and sternpost to be made of bronze, it necessitates the most skilful workmanship, it adds 10–12 per cent. to the weight of the hull and 15 per cent. to the cost, and if there are hidden imperfections in the workmanship corrosion is still possible. The second method is much simpler in theory, but in practice it has been found exceedingly difficult to obtain a paint with the requisite qualities.

It was with the above ideas in view that the Naval Advisory Board, in 1883, recommended to the Hon. Secretary of the Navy that a series of tests be undertaken in order to determine the best paint for the bottoms of the new cruisers. The recommendation being approved, manufacturers of paints were notified through the press, and circulars were sent descriptive of the objects of the undertaking and the method of procedure. Naval Constructor S. H. Pook, at the Washington Navy Yard, was placed in immediate charge of the experiments, and under the supervision of the Board the following programme was carried out: 496 plates, 3 ft. square and ⅛ in. thick, of the same quality as that used for the outside plating of the cruisers, were obtained. All but 16 of these plates were carefully cleaned by immersion in a bath of sulphuric acid and water, and then washed and dried. There were 28 different manufacturers competing, and 16 plates were painted with each kind of paint, 16 plates were also painted with a mixture of red lead and white zinc, 16 with pure red lead, and the 16 uncleaned plates were also painted with red lead.

The plates having been prepared, they were placed in cages, each cage containing 8 plates, 3 inches apart, carefully insulated from each other and from the cage by rubber. The cages were then distributed between Portsmouth, N. H., Washington, Norfolk and Key West, so that each kind of paint was represented on two plates at each locality. At the three northern places the cages were suspended from scows secured in favorable situations. At Key West it was found necessary to suspend them from an open wharf. In addition, the iron tug Speedwell was painted with each kind of paint, the bottom being blocked out so that the paint farthest forward on one side was the farthest aft on the other. At the water-line red lead and white zinc only were used.

The plates were immersed and the Speedwell launched in December and January, 1884. The first examinations were made in May and June, 1884, and the second in September and October, 1884.

At each examination a most minute and careful record was made of the following particulars: 1. Proportion of plates from which paint was peeled. 2. Proportion of paint loose or blistered, or from which anti-fouling was dissolved. 3. Average thickness of fouling. 4. Nature of fouling. 5. Evidences of corrosion or pitting, and in addition, on the bottom of the Speedwell, the time of drying of the fouling. During the interval of the tests the Speedwell had been from Washington to Portsmouth, N. H., but had remained most of the time at Norfolk.

As a result of the tests, the paint of Mr. P. G. West, of Wilmington, Del., was shown to be, under these circumstances, excellent. Its plates were only slightly foul, and on the Speedwell its space was almost absolutely clean and perfectly dry in a few minutes after the water had left it in the dock. In all cases it had adhered to the plates well and there was not the slightest evidence of corrosion. The paint of Mr. Gould, of Newark, N. J., was next in order, but considerably behind the West paint. The paints of Messrs. Devoe and Messrs. White & Co. were far behind the Gould. All the others were unsatisfactory.

Recognizing, however, that where so many conditions are involved, a change in any may produce variations in the results, and as many applications from manufacturers were received after the tests were commenced, the Board has recommended another series of tests to be made, believing that the results will be valuable in proportion to the number of tests. This second series has already commenced, with 52 different samples.

The report of the Naval Advisory Board was published in full by the Department.

A FALLACY IN COMPOSITE GREAT-CIRCLE SAILING.

By Commander C. D. Sigsbee, U. S. N.

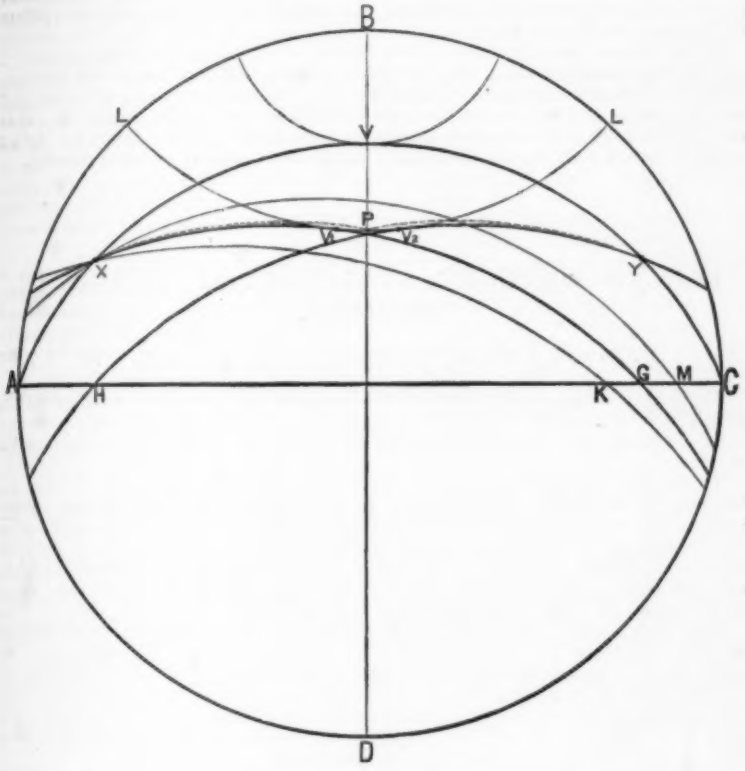
In the *American Journal of Mathematics*, for December, 1881, appears a paper, by Mr. Marcus Baker, which discusses an extension of Alhazen's problem to include cases of composite great-circle sailing. This paper, after reciting that the solution of Alhazen's problem gives the minimum path between two points and an intermediary circle, the points and circle being situated in the same plane, then proceeds to the solution of the same problem when the two points and the circumference of the given circle are situated in the surface of a sphere.

When the great-circle arc joining two places leads into higher latitudes than a navigator is willing to attempt, he decides on some lower latitude to which he intends to restrict his route, and he then composes his route in such a way as to obtain, under the restriction of limited latitude, a minimum distance between the places.

Unless the two given places are diametrically opposite points of the sphere, only one great circle can join them, and the commonly accepted shortest route, or composite route, between them in other cases, when the latitude is restricted, is made up of two arcs of great circles tangent to the limiting parallel of latitude through the two places and that arc of the parallel which is included between the points of tangency, or vertices, of these component great-circle arcs.

In the paper in question it is stated that the shortest path which does not pass beyond the limiting parallel of latitude, consists of two arcs of great circles drawn from the two places to a point upon the parallel in such a manner as to make equal angles with the parallel at that point. The object of the paper is to determine this point.

In determining his point, Mr. Baker fails to notice that his path passes beyond the limiting parallel, thus violating an essential condition of the problem in its relation to practical navigation.



The accompanying figure is a stereographic projection of the sphere upon the plane of a meridian. B and D are the poles, AC the equator, and AVC a great circle having its vertex at V. X and Y are two points upon this great circle, assumed in the same latitude for convenience of construction. LV_1V_2L is the limiting parallel. XV_1G is a great circle tangent to the parallel through X, and V_1 is its vertex or point of tangency. YV_2H is a great circle tangent to the parallel through Y, and V_2 is its vertex.

The ordinary composite great-circle route from X to Y is from X to V_1 upon the first great circle, from V_1 to V_2 upon the parallel and from V_2 to Y upon the second great circle. Mr. Baker's route is shown by the dotted line, P being the point which he determines, and which in the case projected falls upon the meridian of the vertex V, since X and Y are in the same latitude.

The limiting parallel will always lie on the polar side of the two places. From each place, then, arcs of two great circles can be drawn tangent to that parallel, one upon each side of the meridian of the place. Only those arcs need be considered which are tangent on the side nearest the other place.

Great-circle arcs through both places cannot have a common point of tangency upon any parallel of latitude excepting that of the vertex of the great circle which joins the two places, for such arcs must lie in the same plane and must therefore be arcs of the same great circle. Hence upon any lower parallel, tangent great-circle arcs through both places will have separate points of tangency as V_1 and V_2.

Great circles through either place, and passing, as XK, on the equatorial side of the corresponding tangent great circle, will not touch the limiting parallel. Those passing, as XM, on the polar side will intersect the parallel in two places and will therefore pass beyond it into higher latitudes. It is seen, then, that arcs of great circles through both places cannot be drawn to meet upon a limiting parallel unless one or both pass above that parallel.

FORCED DRAUGHT BY REVOLVING SCREW IN CHIMNEY.

By Passed Assistant Engineer John C. Kafer, U. S. N.

There have been some experiments made at the New York Navy Yard recently, with a revolving screw propeller in a chimney, which, when sufficient data have been obtained, will undoubtedly solve the question of forced combustion on shipboard.

These experiments were made by direction of Engineer-in-chief Charles H. Loring, U. S. Navy, Chief of the Bureau of Steam Engineering, Navy Department, who tried, in 1869, the effect of a screw propeller in a smoke pipe for the purpose of increasing the rate of combustion of coal. The results at that time showed that a great deal more coal could be burned per square foot of grate with a very large increase in the quantity of water evaporated per hour, than when burning coal by natural draught in the same boiler.

The trials made at New York with the boiler in the foundry of the Steam Engineering Department, showed that with natural draught and using the full grate surface of the boiler—twenty-four square feet—a ratio of heating to grate surface of 23.87 to 1, and a calorimeter through the tubes of about one-seventh the grate surface, the mean of 15 experiments of 16 hours each gave a consumption of 15.417 pounds of anthracite coal per hour per square foot of grate, with clean fires forced to maximum.

It is probable that not more than 13½ lbs. of anthracite coal per square foot of grate would be burned if the boiler was in the hold of a vessel, where the openings to the fire room are obstructed to the free passage of air, and where the passage from boiler to smoke pipe is not so direct as in the boiler used in the New York Navy Yard.

The chimney used is 70 feet in height above the grate, which is much more than the height of smoke pipes generally found on vessels of war.

With the screw in operation in the chimney, the mean of 10 experiments, averaging 16 hours each, gave a combustion of 17.917 lbs. of anthracite coal per square foot of grate, with 0.39 of one per cent. less water evaporated per pound of coal, but with an evaporation of about one-sixth more.

In the experiment with the screw, the boiler had the same grate surface, heating surface and calorimeter as in the previous experiments with natural draught, and it was apparent that the area through the tubes (one-seventh of the grate surface) was much too small, as the pressure of the atmosphere in the fire room was at times equal to a column of five inches of water above the pressure in the smoke pipe below the revolving screw.

A second series of experiments were made reducing the area of grate to 13½ square feet, keeping the same area through tubes and the same heating surface. This gave a ratio of heating surface to grate of 42.44 to 1 and a calorimeter through the tubes of about one-fourth the grate surface.

The maximum combustion with natural draught, under these conditions, as shown by a mean of four experiments of 16 hours each, was 19 pounds of anthracite coal per square foot of grate per hour.

With the screw in operation in the chimney and like proportions of boiler, the mean of five experiments of 16 hours each gave a combustion of 38.44 lbs. of anthracite coal per square foot of grate per hour, with an evaporation of 0.777 of a pound of water less, per pound of coal, than with natural draught.

With the screw and the changed proportions of boiler, the rate of combustion per square foot of grate was more than doubled, and the quantity of steam generated per unit of time was 80 per cent. more.

To take advantage of the benefits so clearly demonstrated by these preliminary experiments, it is necessary to make further trials to determine the relative proportions of heating surface, and area through tubes to grate surface for marine boilers; and when these proportions are established, the boilers of war vessels can be fitted with an appliance that will double their power in cases of emergency, without at all interfering with the ordinary conditions of burning coal with natural draught, and steaming at an economical cruising speed, as it was shown in these experiments that the presence of the screw in the chimney did not at all affect the rate of combustion with natural draught.

An eminent engineer who has seen the result of these trials and witnessed the operation of this principle, said that this is the only practicable solution of the forced draught problem.

The hatches and passage-ways can be kept open, and all conditions are the same as when burning coal with natural draught, and therefore will not have the same effect on the morale of the men as a closed fire room.

In comparing this system with that of a closed fire room where the pressure of air is maintained above the atmospheric pressure, it would seem at first sight to be less economical as far as power required to produce draught is concerned, as the gases generated by the combustion of coal, as well as the air supplied for combustion, must be moved by the screw in the chimney when they are highly heated and have a greatly increased volume, while with a closed fire room the air moved is of the temperature of the atmosphere.

The volume of air moved in the case of the closed fire room may be much greater, however, than the volume of heated gases in the smoke pipe, on account of the unavoidable leakage, which in large fire and boiler rooms is very great; the coal bunkers must also be under pressure, as a free communication must be maintained between fire room and coal bunker; for these reasons it is believed that less power will be required to drive the screw in the chimney than to maintain sufficient pressure in the closed fire room to burn the same amount of coal per square foot of grate.

ORDNANCE NOTES.

No. 1.—Cartridge Cases.

The magazine arrangements of the new cruisers will differ radically from those to which we have been accustomed, the change arising from the enormous increase of powder consumption in modern guns.

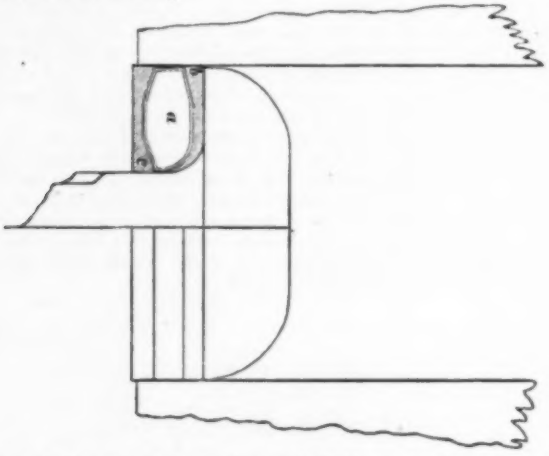
Each cartridge will be carried, at all times, in its own "cartridge case"—a long cylinder of zinc, brass or other suitable material. The 6-inch cartridge will have covers *a*, *a*, at the ends, similar to those of an ordinary blacking box, except that these are fitted with handles *b*, *b*.

Collars *c*, *c* are soldered to the cylinder—a space being left between them and the covers when in place. In this interval stout twine is wrapped and the end is allowed to hang out. Over the twine is laid shellacked paper. The joint is sealed with shellac, and rendered watertight with asphalt varnish or other proper substance. The cases will serve the combined purpose of powder tanks, passing boxes and loading cylinders. They will be stowed in racks in the magazine, will be whipped up, when wanted, by the handles and taken to the gun. One cover being removed, the case will be inserted into the breech of the gun, the second cover removed and the cartridge pushed into the chamber from the rear by means of a short rammer.

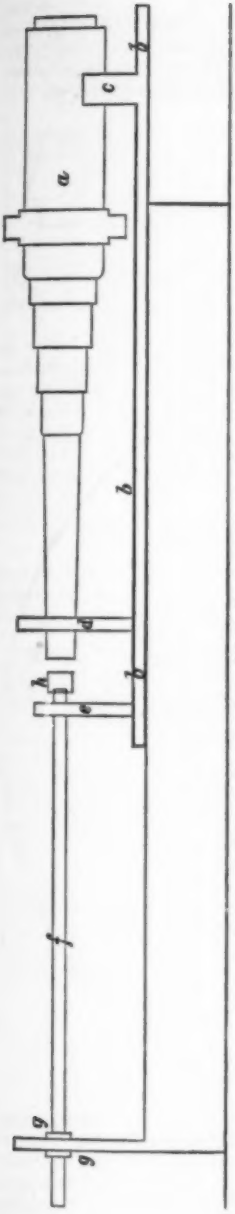
For large calibre (8-inch and upwards) a mechanical joint may be used to connect the cover and cylinder. A number of simple and serviceable schemes are under consideration. The interrupted screw, the bayonet joint, a flat profiled thread, etc., etc., have already been tried or discussed; but the blacking box type is found to be strong enough and tight enough for all practical purposes. When it is remembered that a 6-inch cartridge is nearly three feet long, and fifty pounds in weight, the necessity for economical storage and facility of handling becomes apparent.

No. 2.—De Bange Gas Check Rings.

In the early application of the De Bange system of obturation to our new steel B. L. R.'s, the pad *a* filled with asbestos and mutton suet, was enclosed between two sets of rings, of peculiar cross section, made of tin, copper or other soft metal or of an alloy.



In practice, at the Naval Experimental Battery at Annapolis, these rings were found, after firing, to stick to the wall of the chamber, and thus to prevent the ready withdrawal of the breech plug. Experience showed the necessity of a harder material—a solution of the difficulty which, by the way, had been, from the first, under discussion theoretically. The premises admitted, the conclusion followed logically and speedily. In June last, the Bureau of



CONVENTIONAL SKETCH OF 6" B. L. R. BEING RIFLED ON A PLANER.

Ordnance ordered a pair of retaining rings, *b* and *c*, to be made of steel. Early in July, after ample trial, they were reported by the Inspector of Ordnance in charge of the Proving Ground (Lieut.-Commander Folger) to be entirely free from tendency to stick in their seats. They were at once adopted as standard.

No. 3.—Rifling Heavy Guns.

The operation of rifling is conducted in a variety of ways. Thus the gun may be fixed and the rifling tool *pushed into* it or pulled *through* it; or, the gun may be movable and the tool fixed longitudinally. In all cases some device is employed for turning the tool during its passage through the bore, so that the cut made may be a spiral of the required nature. Again, one groove or many may be taken at a time. Within these limits it is seen that there exists a wide field for diversity of practice; for instance, Woolwich cuts *one* groove at a time by *pulling*, while we cut *several* by *pushing*.

At the Ordnance Shops of the Washington Navy Yard, for want of a rifling machine of the usual type, the 5″ and 6″ B. L. R.'s have been rifled on a Sellers planing machine. The gun *a* is laid on the planer table *b*, supported on a chock *c*, and carried in a collar *d*, by which it may be revolved about its axis, and a new surface of the bore presented to the rifling tool whenever desired.

On the muzzle end of the table is a standard *e*, which passes freely along the rifling bar *f*, and serves as a support to it.

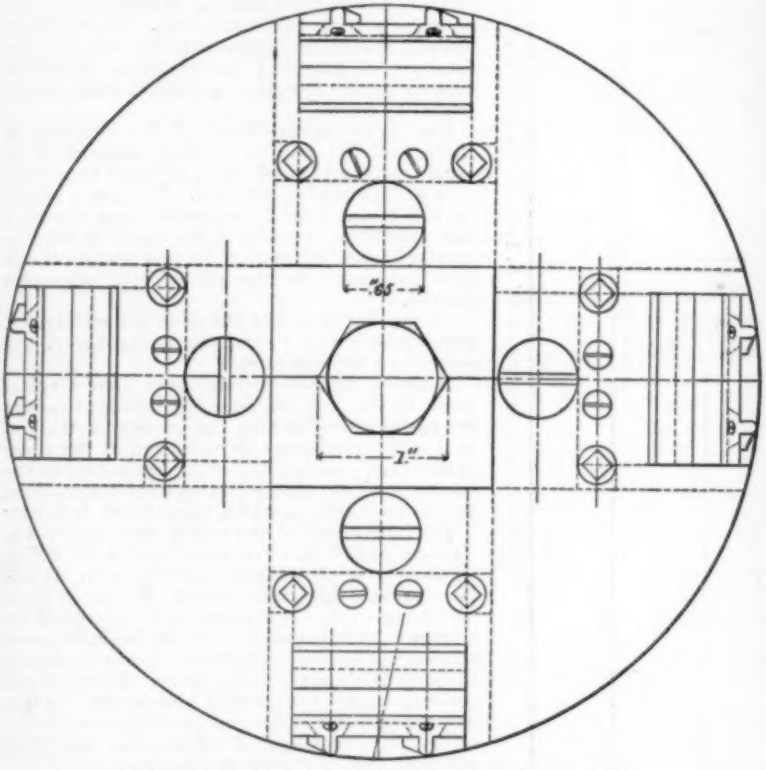
It has a stud projecting down into a spiral score in the bar. Necessarily, this stud causes the bar to rotate, making the groove in the gun an exact reproduction, in character, of the score in the bar. The rear end of the bar is held at the extremity of the planer bed against longitudinal strains by collars *g*, which leave it free to rotate.

The other end of the rifling bar carries the "rifling head" *h*. The details of a 6″ rifling head are given in the accompanying cuts. It will be observed that eight grooves are cut at once, and that each tool is independently adjustable by a screw as to depth of cut. Before beginning, set-screws, not shown in the drawing, are regulated to stop the tools at the *extreme* depth of the groove, and are not touched afterwards. In this way the operator is debarred from the possibility of making mistakes of adjustment, and thus ruining a gun by cutting too deeply.

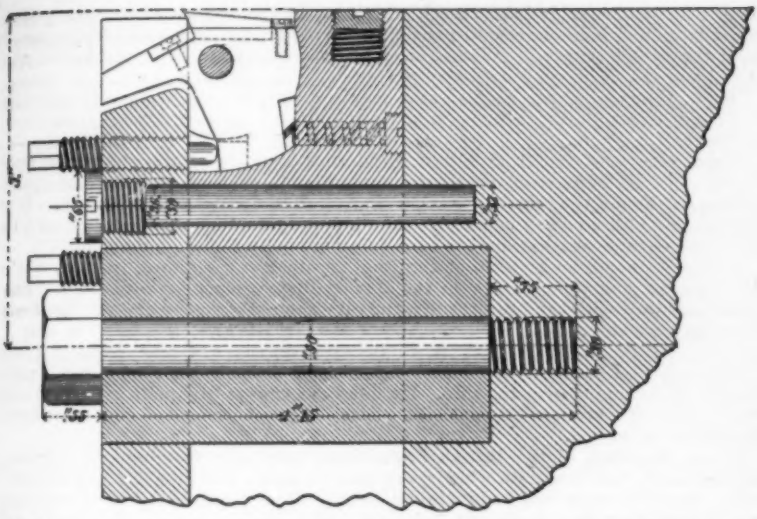
The head here given was made last year by direction of the Inspector of Ordnance, and in view of the need of more rapid working than had been the practice before. It is merely an adapt-

ation of the tool previously employed, modified so as to take eight independent cuts instead of one cut, single or double. It has already justified its greater cost in reducing the time of rifling a gun from about 12 days to 4 days. The twenty-four grooves of a 6-in B. L. R. are now "roughed out" in eight hours. Plans are also elaborated for a head to act by *pulling*, if found desirable, wherein

the condition of independent adjustment for each cutter is maintained. The scheme described is evidently capable of expansion so as to cut as many grooves as may be desired and found practicable.



ELEVATION OF 6-INCH POLYGROOVE RIFLING HEAD.



POLYGROOVE RIFLING HEAD—DETAILS OF TOOL-POST AND CUTTER.

USE OF OIL.

The Hydrographic Office has been collecting data to determine under what circumstances the use of oil is most efficacious in diminishing the danger of breaking seas during gales of wind.

Masters of vessels are requested to make experiments in this matter whenever the opportunity occurs, and report the results to one of the Branch Hydrographic Offices, or directly to the Central Office at Washington.

When sufficient data have been collected a pamphlet will be issued giving such directions in regard to the use of oil as the common experience of seamen may determine to be the best.

The following accounts have been received lately:

Capt. R. S. Thompson, S. S. Sacrobosco, reports using oil in 1880, and twice during the month of February, 1885. In each instance, after getting his ship before the wind, he put over oil bags with the best results. In the first case the engines were slowed so as not to lose too much to leeward, and it was proved clearly that with the use of oil it is not necessary to run as fast as is generally supposed.

Capt. Smith, of the English bark Emma, used refined petroleum during a gale in which his vessel was abandoned. He found it entirely useless, although barrels of it were emptied to windward, and seven or eight bags of it were towed alongside. About five gallons of crude turpentine or pine oil was used with good effect as long as it lasted.

Capt. Geddes, of the S. S. Erato, in February, 1885, instead of heaving-to during a favorable gale, concluded to run. He shipped some very heavy seas, which did great damage until the oil bags were put over, when the ship ran comfortably with the decks perfectly dry.

Capt. Daniel Thomas, of the British barkentine Corisande, in January, 1885, during a gale, while lying-to, was boarded by a heavy sea which washed one

man away and disabled the vessel, which lay in the trough of the sea. Men were stationed immediately to pour oil overboard until bags could be prepared and the vessel secured. When this was done she was easily got before the wind and ran very comfortably.

Capt. Johnson, of the English steamer Emerilda, reports using oil bags with excellent effect, during a heavy northwest gale, on his last voyage from Port Royal to Liverpool.

Capt. Moore, of the British bark Siddartha, says that during the last four years he has frequently used oil bags when hove-to or running, and has invariably found they made a wonderful change in the nature of the sea. His system is to fill a coarse bag with oakum, thoroughly saturated with oil, and to hang it over the weather bow, if hove-to, or to the bumkins, if running.

Chief Officer John Matson, of the English steamer Edinboro, in 1881, while lying-to in a mountainous sea in the Bay of Biscay, placed two oil bags overboard forward with the best results, the oil effectually preventing the sea from boarding the ship.

Capt. Scott, of the English S. S. Briscoe, during a recent passage from Baltimore to London, experienced heavy gales from WNW. to WSW., with high seas sweeping over the ship. He filled two canvas bags with oil and towed them over the stern with excellent effect, as they prevented the seas from boarding the vessel.

Capt. Mumford, of the British S. S. North Anglia, in October, 1884, during a hurricane, had his main wheel gear carried away, and was obliged to steer aft. After the men had been washed away several times he tried oil and had no further trouble. Again, in February, 1885, while hove-to, he poured oil through a pipe on each side of the forecastle. Oakum was put loosely into the pipes to prevent the oil running too quickly. After commencing the oil no dangerous water was shipped.

Mr. G. Foster Howell, of New York, sends a very interesting account of the use of oil while off the Horn in the ship Cavalier in 1876. The ship had been run too long, and heavy seas were constantly boarding her. At last one more powerful than the rest rushed upon her with awful violence and started the deck. At the writer's suggestion oil bags were towed overboard with about 25 feet of line, one on each quarter and one amidships. "No sooner had the oil commenced to leak than the sea ceased to boil and rage, and the waves became so harmless that they no longer broke upon us."

WAVE MOTIONS.

The ships of the U. S. Navy have been engaged for some time in making observations of the dimensions and speed of deep-sea waves. These recorded observations are not so complete or numerous as is desired, and any assistance in this respect will do much to advance one important branch of the science of naval architecture.

The observations made where a ship falls in with a single series of approximately regular waves are most valuable, and should be accompanied by full records of the attendant circumstances.

One method of measuring the wave lengths consists in towing a log line astern of a ship and noting the length of line when the chip floats on the wave crest next abaft that on which the stern of the ship momentarily floats. The ship should be head on, or allowance made for the departure of the log line from the head on position.

To measure the wave heights, when the ship is in the trough of the sea, and for an instant upright, the observer takes up a position such that the successive average wave ridges, as viewed by him from the trough, just reach the line of

the horizon without obscuring it. The height of the eye above the water level correctly measures the height of the waves. To measure very high waves the observer may have to ascend the rigging, while for waves of less height a station on one of the decks may suffice, or some temporary expedient devised for placing the observer near the water level. It is desirable to select a position as nearly amidships as possible, but if it becomes necessary to take a station near the bow or stern, allowance must be made in estimating the height of the eye above water for the deeper immersion which may be caused at the instant by pitching.

The longest recorded wave measured a half a mile from crest to crest, with a period of 23 seconds. Waves having a length of 500 or 600 feet, and periods of 10 to 11 seconds, are the ordinary storm waves of the North Atlantic.

In regard to the heights of waves, the most trustworthy measurements show from 44 to 48 feet to be a remarkable height. Waves having a greater height than 30 feet are not commonly encountered.

The Hydrographic Office has blank forms for recording these observations, and would be glad to furnish them to any shipmaster who takes sufficient interest in the subject to make observations whenever the opportunity occurs.

ON THE LAWS OF PENETRATION OF WROUGHT IRON PLATES.

The following is a translation of a mémoire by M. Martin de Brettes, published in the Comptes Rendus of the Paris Academy of Sciences, tome 99, No. 17, October 27, 1884.

An examination of Krupp's experiments upon the penetration of armor plates shows, calling $2r$ the diameter of the projectile, t the thickness of the plate, and e the energy of the shot per unit cross section, that:

1st. When $2r$ is constant, the quantity $\frac{e}{t}$ increases with t; so that the curve representing the relation between e and t may be considered a parabola.

2d. When t is constant, the quantity $\frac{e}{r}$ decreases when r increases, so that the curve between e and r may be considered a hyperbola.

3d. When $\frac{2r}{t}$ is constant, $\frac{e}{t}$ is also constant.

So that the law connecting the three variables r, t and e must be written so that the value of e shall be represented by a parabola, a hyperbola, or a straight line, according as $2r$, t, or $\frac{2r}{t}$ is constant.

The following form satisfies these conditions,

$$e = at + b\frac{t^2}{2r}. \qquad (1)$$

The following numerical data are given as proof of the three laws:
For the first, when $2r$ is constant, for the 15 cent. gun:

t	Δt	e	Δe	$\frac{\Delta e}{\Delta t}$
cent.		tonnes-métres		
15		1.500		
	5		.700	.140
20		2.200		
	5		.770	.154
25		2.970		
	5		.830	.166
30		3.800		

For the second, when t is constant, for $t = 20$ cent.

$2r$	$\Delta.2r$	e	Δe	$\frac{\Delta e}{\Delta.2r}$
cent.		tonnes-mètres		
12		2.400		
	3		.200	.066
15		2.200		
	2		.080	.044
17		2.120		
	3		.050	.016
20		2.070		

For the third, when $\frac{2r}{t}$ is constant, for $\frac{2r}{t} = .75$.

$2r$	t	e	$\frac{e}{t}$	diff.
cent.	cent.	tonnes-mètres		
12	18	2.060	.114	
				+ .002
20	30	3.470	.116	
				— .001
24	36	4.149	.115	
				.000
28	42	4.830	.115	

The above results determine the constants in (1), and give, in the units of the numerical data,

$$e = 0.073t + 0.027\,\frac{t^2}{2r}. \qquad (2)$$

This formula has been tested by repeated application to Krupp's results, and gives, when compared with experimental results, quantities which are sometimes too large and at others too small. It is thus thought to represent well the law connecting the three variables.

If we change (2) so that e shall be in foot-tons per square inch, and t and r in inches, it becomes

$$e = 3.863t + 1.429\,\frac{t^2}{2r}. \qquad (3)$$

The penetrating power of shot is sometimes considered to depend upon their energy in foot-tons per inch of circumference, and (3) may be easily transformed to suit this. If e_1 be the energy so stated, we have evidently,

$$\frac{e_1}{e} = \frac{r}{2},$$

whatever value t may have. Inserting this relation in (3), we have

$$e_1 = 1.932tr + 0.357t^2. \qquad (4)$$

The particular curves represented by (4) when $2r$, t, and $\frac{2r}{t}$ are constant, will not, however, be the same as before.

The differences between the values given by (4) and by experiment are greater than in the case of (3), and they increase as the diameter of the projectile increases, since they have been multiplied by $\frac{r}{2}$.

REVIEWS.

LE TIR DE L'ARTILLERIE DE CAMPAGNE. Par Major H. Rohne; traduit de l'allemand par le Capitaine Bodenhorst, de l'artillerie belge. Bruges: C. De Laroière, 1883.

The formation of rules by which to correct the fire of guns by the observation of the points of fall of a number of projectiles is now attracting much attention in Europe, and the rules which have been adopted by the Prussian land artillery are given in the above work. The subject is somewhat dry reading; it consisting here of nearly 400 pages, giving the minute detail of rules for governing the many kinds of fire which may occur.

It is to be regretted that the author does not give more fully the reason for the rules laid down. As is commonly the case with works of this kind, the reader is supposed to know all about the guns of whose use it treats. There is, however, much which is valuable and interesting in it, and from the great importance of the subject it cannot fail to be of interest to naval officers.

The rules given are applicable to the use, under the direction of one officer, of a considerable number of guns on a fixed platform, and these are by no means the ordinary conditions of practice at sea, where we seem likely to have comparatively few guns; but the principles governing the formation of rules are the same, and thus reading the work must develop an officer's usefulness in an important particular.

TRAITÉ DE BALISTIQUE RATIONNELLE. Par J. Bailly, Lieutenant de Vaisseau. Paris: Libraire Ch. Delagrave, 1883.

This work, as its title asserts, is a treatise on rational or abstract ballistics. It contains, as the author states in his preface, the treatment of some questions which are of theoretical curiosity rather than practical use. For example, the deviation of projectiles due to the rotation of the earth is treated at length; as is also the difficult subject of the rotation of projectiles in flight. The latter may, it is true, become of practical use by leading to the best methods of manufacturing projectiles and centering them in the bores of guns. The author has divided his subject into five books, having the following headings: Exterior Ballistics, Interior Ballistics, Deviations of Projectiles, Pointing and Firing Guns, Theory of Recoil. There is nothing calling for remark in the first book; the numerical solution of the trajectory in air is of course not attempted. The second book is divided into two principal parts: Geometrical and Thermodynamic study of guns. The former is of importance as presenting certain simple notions which lead to a clear conception of the phenomena which occur in the bore of a gun when the charge is fired; while the latter is a digest of the work of Sarrau, Saint-Robert, Noble and Able, and Clavarino. It may be worth noticing that the work of the last named author called Puissance de la Poudre, published in the Journal de l'Artillerie Italienne, which appears little known in this country, is frequently quoted as the most complete treatise yet published regarding this matter. The subject of deviations, as treated in the third book, has little or no application in practice. The subject of pointing and firing guns is well and clearly treated, and many facts and principles, a knowledge of which is essential in the use of guns, are to be found

here collected together. The last book, concerning the recoil of guns, contains the theory of that subject as applied to frictional and hydraulic checks.

The subject-matter of the book is presented generally in a mathematical form, as must be the case in a work of its intent. The methods used (with the notable exceptions of the deviations of projectiles, the thermodynamic study of guns, and the application of the theory of probability to the fire of guns, for example) are simple, and are accessible to a person who has a knowledge of the principles of mechanics.

A TREATISE ON THE APPLICATION OF WIRE TO THE CONSTRUCTION OF ORDNANCE. By James A. Longridge, C. E. E. & F. N. Spon, London and New York, 1884.

The use of wire in the construction of guns seems growing in favor, and the importance of a work on the subject by so eminent an engineer as Mr. Longridge cannot be overestimated. The first sensation of the reader who picks this book up must, however, be one of disappointment. The author states that it contains the results of investigations which began as long ago as 1855; and, if one may judge by its disjointedness and the great confusion in the mathematical notation, it must have been growing in an irregular way during all that time.

The fundamental formulae used by Mr. Longridge are those usually known as Lamè's or Rankine's. The most satisfactory and simplest method of deriving these two laws concerning the elastic strength of thick hollow cylinders which has yet appeared is due to Professor Cotterill, and will be found in his Applied Mechanics (London, Macmillan & Co., 1884); Mr. Longridge's method cannot compare with it in simplicity and elegance. Throughout the work the question of the *compound* strength of guns, in which subject Clavarino is at present the received authority, is not touched upon.

Notwithstanding the extremely bad mathematical methods which Mr. Longridge has used and the other faults which have been pointed out, no one who wishes to make himself a specialist in this subject can fail to read this book. As for the student who is beginning the subject, he had better begin elsewhere.

APPLIED MECHANICS: AN ELEMENTARY GENERAL INTRODUCTION TO THE THEORY OF STRUCTURES AND MACHINES. By James H. Cotterill, F. R. S. London: Macmillan & Co., 1884.

The author's position as professor of applied mechanics at the Royal Naval College, Greenwich, led to the preparation of the above work for the use of the students placed under his charge, and it is therefore well adapted to the wants of naval officers. Indeed, one cannot read it without feeling that he owes a personal debt of gratitude to Professor Cotterill for the fund of information and good sense which he conveys.

The work is divided into five parts: Statics of Structures, Kinematics of Machines, Dynamics of Machines, Stiffness and Strength of Materials, Transmission and Conversion of Energy by Fluids. These subjects are all treated by simple and clear methods, and the principles set forth are illustrated by numerous examples. In very many cases the problems are such as are of daily occurrence in the seafaring profession; and it seems fair to assert that, both with regard to the excellence of the methods used and the nature of the subject-matter, there is no recent book on mechanics so useful and valuable to naval officers as this one.

The Proceedings of the Royal Artillery Institution, for March, 1885, contains a very full description, with drawings, of an experimental hydraulic field carriage. When the nature of the service to which such carriages are subjected

is considered, this one appears somewhat complicated and elaborate in its details; but it serves to show the increasing demand for perfected apparatus in the handling of light guns even.

There is also an account of some practice with 9-inch M. L. R. mounted in a fort in the Isle of Wight, at ranges of 1600 to 2300 yards in firing at a moving object. The latter was an old boat, 20 feet long, with a triangular framework, surmounted by a flag erected on her; this target was towed in front of the battery at the distances already mentioned at a speed of about 5 miles an hour. Of 39 shots fired, 3 hit the target; and the mean point of impact of the 39 shots was situated 23 yards beyond the target and in the line drawn from the guns to the target. The range was found for each shot by a Watkins range-finder, the sliding leaf being set to allow for speed of target and effect of wind by the estimation of the officer in charge of the battery. The good judgment shown by the latter is apparent; since the lateral coordinate of the mean point of the impact is zero. The range finding seems to have been efficiently performed also; since, if the angle of fall was 3°—as was probably about the case—we find the mean point of impact to be situated in the *vertical* plane passing through the target at the middle of the boat's length and 1¼ yards *above* the water line. This is, unquestionably, about the proper adjustment of the mean point of impact in firing at such a target, for with the flat trajectories now ruling, a shot which passes some distance beyond the target, clears it by comparatively little, while shots which strike short, from the irregular ricochet of elongated projectiles, may be almost counted as lost.

There is also in this number a description of the objects of a Russian School of Gunnery recently established, and a statement of the rules governing it. The objects are stated to be: (1) the preparation of senior artillery officers for the duties of battery commanders; (2) to develop the instruction of gunnery in the artillery; (3) to spread through the artillery rational ideas with regard to the employment of fire in action; (4) to ensure uniform teaching with regard to gunners. The course at the school lasts one year, and certain officers are detailed, at stated intervals, to take it. The precise line of instruction adopted is very imperfectly indicated; but it appears to be of a practical, rather than theoretical nature.

As showing the extraordinary pitch to which the development of military science is being brought in Europe, it is interesting and curious to observe in some extracts from German newspapers which are given that the attempt is now being made to find how much labor the human frame can endure when put on short rations. Healthy, vigorous men are selected, and being confined to a strict campaigning diet, are marched for six hours a day in full marching order for a fortnight. They are weighed frequently, and many observations of their physical condition are made. The object of these experiments is two-fold: to find what the men can stand, and what food will best sustain them. No results are given.

Les Armées Étrangères en campagnes. Par A. Dally, Lieutenant Colonel Commandant de 98e regiment territorial d'infanterie, 1885. Paris: Print of the Typographical Society. A pamphlet of 106 pages with 80 illustrations, giving a general description of the armies of England, Germany, Austria, Russia, Italy, Spain and Switzerland, their organization, strength and how stationed. The illustrations show the uniforms, arms and accoutrements of the different corps and regiments.

BIBLIOGRAPHIC NOTES.

AMERICAN GEOGRAPHICAL SOCIETY BULLETIN.

No. 3, 1884. The life and scientific works of Arnold Guyot, by Professor William Libbey, Jr. A remarkable globe map of the sixteenth century, by A. E. Nordenskiold. Map. A trip from Söul to Peng-Yang, by J. B. Bernadou, U. S. Navy.

Ensign Bernadou, who has been for some time in Corea on special duty, gives us in this interesting article an insight into some of the customs and manufactures of the Coreans, as well as a description of the country as observed by him while travelling under escort from Söul, the capital, to Peng-Yang, the second city of importance in the Empire. The distance between the two cities is two hundred miles, and the journey was made on horseback. One of the cities visited by the writer, Song-To, the capital of Corea under the Ui dynasty until 1392, is especially mentioned, as to it many Corean families trace their origin—and in consequence of which the streets are lined with *pi* or stones commemorative of the terms of office of different officials, while other monuments of a similar nature are enclosed in gaudily painted buildings and are protected by a railing. Ensign Bernadou remained in Peng-Yang some ten days, and received no ill treatment from the inhabitants beyond a laugh at his appearance.

A journey from Cumberland Sound and on the west shore of Davis Strait in 1883 and 1884, by Dr. Franz Boas. Map.

Dr. Boas, a German explorer, surveyed Cumberland Sound and a large part of Davis Strait during a period extending from October 1883 to July 1884. He has corrected many inaccuracies existing on the English Admiralty Charts, founded upon former reconnoissances and upon the information obtained from English and Scotch whalers, besides adding new discoveries. The map accompanying the article indicates the extent of the survey and the corrections made. Dr. Boas' work was much impeded by reason of the dog disease which was particularly violent at Cumberland Sound in the fall of 1883, and by an epidemic of diphtheria among the Esquimaux being ascribed to his presence among them. The article contains a full account of the journeys made in prosecuting the survey, and a short summary of ethnographical observations made.

No. 4. Arctic Meeting at Chickering Hall, November 21, 1884, for the reception of Lieutenant A. W. Greely and his surviving companions.

A number of the Greely Relief Expedition and some prominent New Yorkers were present. Mr. Chief Justice Daly introduced Lieutenant Greely, who made an interesting address in conversational style, and received frequent applause. He stated that the expedition was not intended for exploration nor for reaching the North Pole, but its purpose was for simultaneous observations of the forces of nature in conjunction with the other meteorological stations proposed by the conventions of Berne and Hamburg on the original scheme of

Lieutenant Weyprecht. That the expedition was inadequately fitted out, "without proper funds, not having just those instruments that we should have." He made a handsome tribute to the work of Lieutenant Lockwood, who travelled 125 miles farther than his predecessor on the same route, and attained latitude 83° 24′ N., the highest yet reached by man. The geographical discoveries and the explorations of the several sledge parties were the chief topics, and no special reference was made to the legitimate work of the party at the Meteorological Station. In speaking of his men he remarked, "I am free to say that I think no better class of men ever went into the Arctic regions, taking them as a whole, than those who went with me. I testify here, publicly and cordially, to their courage, to their good temper and willingness to bear hardships."

He spoke pathetically of the good qualities of the dead, and concluded by expressing a hope that a suitable monument would be erected to their memory. Rev. Roswell D. Hitchcock, Prof. Theo. Dwight and General Egbert L. Viele made appropriate addresses, in which the effort to support Arctic Exploration was ably attempted. Nothing to show the commercial or scientific value of further exploration was stated, and the eloquent speakers dwelt on the indirect influences exerted, and the lessons of self-denial and suffering taught by the valorous deeds of the Greely Expedition.

Exploration of the Yukon River in 1883, by Lieutenant Frederick Schwatka, U. S. Army.

This article gives many interesting details of a raft journey of 1303 miles on the Yukon and notes on the topography and resources of the region. The most important statement is as follows: "Alaska has a grand future with its certain fisheries of seal, salmon and whales, paying us annually in them alone half its original cost of $7,000,000. The whaling ground is one of the most important ones left in the world, and paying yearly a million to our citizens; while salmon exist in her rivers in greater number than ever found in the Columbia, the present source of nearly all our supplies. Cod banks stretch along her coast that are so wide and long that they have never yet been outlined, and only feebly invaded as a commercial enterprise. Signs of precious metal are found everywhere, and her southeast islands would furnish ample timber supply for grand commercial cities; while those of the southwest would give grazing ground enough to supply the markets of a score of San Franciscos."

ANNALEN DER HYDROGRAPHIE UND MARITIMEN METEOROLOGIE.

PART I, 1885. The indirect or approximate solutions for the two-altitude problem (continuation). Fernando Po, from report of German Corvette Möwe. Hydrographic investigations of the Nordenskjöld expedition to Greenland. Remarks upon Loma-Loma in the Viti Group. Description and sailing directions for the Paracel Islands in the China Sea. Report on the temperature coefficients of the 84 chronometers tested at Wilhelmshaven in the winter of 1883. The international conference at Washington, for the establishment of a common prime meridian and universal time.

PART II. The indirect or approximate solutions for the two-altitude problem (conclusion). Extracts from the voyage report of the German bark Jupiter. [These relate to Sydney and Newcastle, N. S. W., Manila and the straits of San Bernadino, Isabel harbor, Basilan Island, Sulu Archipelago.] Deep sea soundings in the N. Atlantic, between Cadiz and the Canary Islands. The weather tele-

graphy and the weather in Japan, 1883–1884. Two typhoons in Japan on the 15 and 17–18 September, 1884.

PART III. Supplement to the article on thunderstorms and hail-formation, by Dr. Andries. Remarks on several places on the West Coast of Africa between Loando and Cape Town, from report of the Möwe. Remarks on Cape Town, Cheribon, Java, thence to Soerabaya, and thence through the Bali straits, from voyage-report of bark Triton. New longitude determinations for the Australian observatory. Absolute determination of the horizontal intensity of the earth's magnetism at Wilhelmshaven. Practical rules for manœuvring in storms.

THE ARMY AND NAVY QUARTERLY. Philadelphia: L. R. Hammersley & Co.

VOL. I, NO. 2, APRIL, 1885. Modern cruisers. By Naval Constructor Theodore Albrecht, Austrian Imperial Navy. (Translated from the German, by Lieutenant W. H. Beehler, U. S. N.)

This is an excellent discussion of the reasons for and against the construction of this class of vessels, and of the steps made towards its development. The writer gives many of the details of some of the most approved and most recent specimens of this type. The recent action of the English Government in arming and attaching to their service a number of swift passenger steamers may have some influence upon this question in the future. The translator increases the value of the article by the addition of a list of the unarmored cruisers of the world, whose speed is fifteen knots or over.

BULLETIN DE LA RÉUNION DES OFFICIERS.

JANUARY 10, 1885. The Maxim Gun.

JANUARY 24, 1885. The voyage of the Jeannette.

In this notice of the book published by Mrs. Delong, appears the remarkable statement that the Jeannette expedition was the first American endeavor to reach the North Pole.

BOLETIN DEL CENTRO NAVAL.

JANUARY, 1885. Buenos Ayres. Scientific progress of the Argentine navy. Description of the English cruising torpedo boat Scout. Lectures on torpedoes and their employment. Continuous firing guns. Describes the Maxim automatic gun. Notes on the fauna and flora of the southern coast of the Argentine Republic (trans.). On some observations seldom employed at sea. State of the Argentine navy. Sounding machines, &c. (Plate). Mathematical investigation of the movements of an auto-mobile torpedo (trans.). Compulsory service. Movements of vessels and naval orders.

ENGINEER.

FEBRUARY 27, 1885. Conclusion of the Spezia plate trials.

Subsequent to the shots with the 100-ton gun, in November last, two shots were fired at each of the plates from a 10-inch gun, with the result that the

Brown and Cammell plates were completely broken up, while the Schneider plate, though badly cracked, withstood four shots. "The Schneider steel has, therefore, on this occasion won a remarkable victory. We could wish that the English plates had beaten it, but it is idle to ignore the fact that they were beaten."

ENGINEERING.

JANUARY 16, 1885. Steamboat equipment of war vessels, concluded January 23d.

JANUARY 23. The United States Navy.

An editorial note upon the annual report of the Secretary of the Navy for 1884, from which the following is taken: "We are not concerned just now to follow the report in the controversy that has arisen in America, and which has found an echo in this country, as regards the merits of the designs for the four new cruisers. Whether the Chicago will be a more efficient war vessel for having beam engines and brick furnaces, whether the Boston and Atlanta would be better with or without their 'peculiar features,' and whether they have too large or too small a sail area, can be more certainly discussed when the vessels have been launched and tried. It is no part of our duty to check a possible waste of American money on naval experiment."

The torpedo boat of the future.

According to the views of "Un Ancien Officier de Marine," the armor-clad ship is obsolete, and in any future war none would venture to sea until all the opposing torpedo-boats had been destroyed. The type proposed for a sea-going torpedo-boat is to be about 130 feet long and 12 feet beam, to be manned by 15 to 18 men, and to carry provisions for 12 to 15 days, and coal for 1500 to 2000 miles. She should be able to steam 22–25 miles an hour, and be armed with six or eight torpedoes and one machine gun. The cost would be about $70,000.

The United States Navy.

A letter written by "an American" in Paris, replying to some of the criticisms upon the action of the Advisory Board, in the editorial above noted. It is not perhaps generally known that one of the members of that Board who recently resigned from the service is living in Paris.

FEBRUARY 6. The autobiography of a Whitehead torpedo.

A serial purporting to give the adventures of a torpedo; in an entertaining manner a deal of interesting matter pertaining to torpedoes in general is given. The author is evidently well acquainted with ship routine.

American naval administration.

A further notice of the report of the Secretary of the Navy for 1884. "In England," the writer says, "we do not allow political considerations to govern the choice of workmen in dockyards. Our statesmen reserve such influence for muzzling the more august members of the naval administration."

Test for cotton seed oil.

Place about one teaspoonful of the oil to be tested in a wineglass, add an equal quantity of nitric acid, specific gravity 1.34, and place the glass in a basin of water kept at 60° F., add a small piece of copper about $\frac{1}{32}$ in. in diameter and $\frac{3}{4}$ in. long, and stir at frequent intervals. At the end of an hour, pure lard or olive oil will show white waxy flakes, and on standing for another hour the oil will have changed to a solid white mass. Pure cotton seed oil produces no flakes. Oils made from petroleum show black gummy flakes after twelve hours, but there is no other change, and mixtures give a soft pasty mass, according to

the nature and amounts of the adulterants. After a few trials with well known mixtures it is very easy to estimate very closely the characteristics of any oil examined.

Paulsen's Torpedo.

A self-propelling and steering twin-screw torpedo, the motive power being liquid carbonic acid. It is automatically steered by means of a compass, and upon any deviation from the course, the needle makes an electric circuit, decreasing the supply to one motor, and increasing it to the other, until the original course is resumed. An ingenious device prevents an alteration in the course when within the magnetic influence of an armor-clad. The shell is made of compressed water-proof paper pulp; a cable, detachable at will, may be used to render the weapon more effective. No official trials have been made.

FEBRUARY 20. Carbon in steel (concluded from February 6).

MARCH 6. Side armor *vs.* armored decks. The Nicaragua Canal project.

MARCH 13. The use of torpedoes in war.

FRANKLIN INSTITUTE JOURNAL.

MARCH, 1885. Tidal theory and tidal predictions. Report of the Board of Examiners, International Electrical Exhibition.

In this is a report concerning the Mangin projector and the McEvoy torpedo detector. The latter is a modification of the induction balance. It is enclosed in a sinker and dragged along the bottom, and if it comes in the proximity of a mass of magnetic metal like a torpedo case, the equilibrium is disturbed and a humming noise will be heard.

JOURNAL DU MATELOT.

No. 9, 1885. The cost of English naval guns.

From a report of the English War Office, it appears that the cost of the B. L. rifles furnished by that department for use in the Royal Navy is about as follows: the 12-inch of 43 tons, $31,000; the 9-inch of 10 tons, and the 6-inch of 4 tons, $3,500. The 16-inch 80 ton M. L. R. cost $52,000 each.

MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

VOL. XIII, Nos. 1 and 2. The advantages and disposition of stations for towing ship-models. Special causes of lung diseases in the navy, and means of diminishing them. Modern cruisers. Experiments with the long 47 mm. Hotchkiss cannon. A quick method of deriving an approximately correct stability curve for one ship from the known stability data of another. Use of torpedoes on board the ships and boats of a war fleet. Rules for manœuvring in storms. Directions for putting electric lights in Russian powder factories, laboratories and magazines. Experiments in England with optical signals. Shipbuilding for the Danish Navy. The opening of a course of lectures on ship-building in the Glasgow University. Sketch of the fundamental conditions and formulæ for calculating the strength of new boiler plates (with tables).

REVIEW MARITIME ET COLONIALE.

JANUARY, 1885. Recent progress in naval ordnance. Historical account of the seaman-gunner. Apparent weight in ships at sea. The French cruiser Dubordieu.

Was launched at Cherbourg in December last, is of wood, 253 feet long, 46 feet beam, and draws 23 feet water. She will carry four 16 cm. guns in barbette towers, two firing forward and two astern, and twenty-two 14 cm. guns in battery, a number of revolving cannons and torpedo tubes on the upper deck. The engine is compound with three cylinders, and is calculated to drive her 14½ knots an hour. Ready for sea the Dubordieu will have cost in round numbers $753,000, divided as follows, construction, &c., $460,000, engine and machinery $153,000, armament $140,000. She is intended for service in foreign waters.

The laws of the perforation of wrought-iron plates (See page 329).

FEBRUARY. Investigations subsequent to shipwreck. Seaman-gunner (concluded). A new boat-lowering apparatus. Commander Fournier's law and its application to a cyclone in New Caledonia. Cryptography and its application to military art. The Farcy gun-boats.

These vessels, designed by M. Eugene Farcy for service in Tonquin, are of steel, 98 feet long and 13 feet beam, weighing about 30 tons each, and drawing two feet of water. The motive power is two paddle wheels, forward in channels which run the length of the vessel; the tiller is also forward. In the centre are the boiler, engine, and coal bunkers. Aft are the quarters for the crew of ten men, lockers for provisions and stores, the anchor, windlass, and a 3-inch gun.

MARCH, 1885. The Min River combats, by Captain Ch. Chataud-Arnault, French Navy. Farragut and Dupont, by E. Grasset, Inspector. The Protectorate of Tonquin, continuation from February No., by Captain A. Bouinais, infantry of the navy (Marine Corps). Cryptography, continuation from February No., by Captain H. Josse, French Artillery. Cholera epidemic of Guadeloupe (continued), by Walther, Surgeon-General French Navy. The Lay torpedo, late improvements, Williams torpedo. Removal of boiler crustation by electricity. Unequal distribution of heat in the two hemispheres, by Lieutenant G. Le Goarant de Tromelin, French Navy.

ROYAL UNITED SERVICE INSTITUTION JOURNAL, NO. CXXVII.

The papers in this number most interesting to naval officers are: "Machine Guns in the Field," by Captain Lord Charles Beresford, R. N., and "What are the Most Urgent Measures that Should be Taken for increasing Her Majesty's Navy?" by Sir Edward J. Reed, K. C. B., F. R. S., M. P. The discussion which follows the latter paper is especially instructive. Some of the remarks come home to us with great force at this time.

Hon. Wm. H. Smith, M. P., former First Lord of the Admiralty, says: "This should not be made a party question. We ought to insist that the conduct of the great services, the Army and Navy, should be altogether irrespective of the petty personal interests of gentlemen either on one side of the House of Commons or on the other. What we want is some system that will rise to the necessities of the case and see that the interests of the country are properly cared for."

Admiral Sir Spencer Robinson says: "Having once obtained the unanimous consent of the country that the navy is inadequate, do not dissipate that by anything like hypercriticism. I never knew a perfect ship, and never shall; therefore stick to one point, stick to this, that the state of the navy is insufficient."

UNITED SERVICE GAZETTE.

JANUARY 24, 1885. The Aquidaban.

This is the name of an armored turret ship, closely resembling the Riachuelo, built for Brazil by Samuda Brothers. The hull is of Siemens steel, with numerous compartments; sheathing of teak and metal extend to a height of two feet above the water-line to prevent fouling, while the stern (fitted with a ram) and the sternpost are of solid gun-metal castings. A water-line belt of steel-faced (Brown) armor seven feet deep and varying from seven to eleven inches thick protects the engines, boilers, and magazines, and the pumps for working the turrets; and an armor-deck two inches thick extends over the engine and boiler rooms, and is so constructed at the bow to strengthen the ram, and at the stern to protect the tiller and steam-steering gear. The engines of 4500 I. H. P. are expected to give a speed of 14½ knots with natural draught; the coal bunkers will hold 800 tons of coal—a quantity calculated to enable the vessel to make 6300 miles at 10 knots an hour. Provision is made by a middle line bulkhead for working the vessel, even if one engine or boiler room be flooded. The two turrets are placed in *échelon* and revolve within armored breastworks covering the loading gear; they and the breastworks and the conning tower on the bow are plated with 10-inch steel-faced armor. The Aquidaban will carry four 9-inch 20-ton Armstrong B. L. R. in the turrets, and four 5¾ in. B. L. Armstrong with Vavasseur mounting on the upper deck, two at the bow and two astern. There are five Whitehead torpedo ports, two on each side and one right aft; a second-class torpedo boat will be carried and fifteen Nordenfelt guns. Nineteen months were occupied in building the vessel, and in three months more she will be ready for sea, making twenty-two months in all, a noteworthy instance of the rapidity with which private English firms can construct such vessels. The Aquidaban is to be ship rigged with steel lower masts; dimensions are as follows: Length between perpendiculars, 280 feet; extreme breadth, 52 feet; draught of water, 18 feet; displacement, 5000 tons.

JANUARY 31. Gun experiments at Woolwich.

A 6-inch steel gun of the new pattern burst near the muzzle on board the Active, in November, 1884, during gun practice when fired with only 17 lbs. of powder, half the service charge. A committee, of which Vice-Admiral Luard was president, was appointed to investigate the cause. As the Active's gun could not have been double loaded, it was suggested that the explosion may have been caused by injudicious lacquering of the bore, or by the presence in the chamber of some foreign substance such as sand, cotton waste or old files. Iron and steel wedges of different sizes and shapes were therefore placed in a similar gun, and after firing, the effects upon the bore and shell were observed. The series of experiments have proved conclusively that the gun was not burst by an obstruction in the bore, and the gun will now be subjected to distortion by letting it fall from a height and by dropping heavy weights upon it, after which it will again be tested.

We have received a beautifully engraved map which has recently been published by the Hydrographic Office, Navy Department, Washington, D. C., of the Polar Regions from Baffins Bay to Lincoln Sea, this latter name having been given to the most northern waters. The map was made under the direction of Commander John R. Bartlett. It comprises the discoveries made

by the Polaris Expedition under Captain Hall, 1872; the British Expedition under Captain Nares, 1876, and the Lady Franklin Bay Expedition under Lieut. Greely in 1881–4. It was in this last expedition that latitude 83 deg. 24 min. was reached, being the highest yet reached by man. Captain Nares reached 83 deg. 20 min. 26 sec. Previously to these records came Captain Parry, in 1827, by way of Spitzbergen, 82 deg. 45 min. Reduced to miles, the Greely party exceeded Captain Nares, on reaching the North Pole, about four miles, and Captain Parry about forty-four miles. This is getting distances down to a pretty fine point.

NAVAL INSTITUTE PRIZE ESSAY, 1886.

A Prize of one hundred dollars and a gold medal is offered by the Naval Institute for the best Essay presented, subject to the following rules:

1. Competition for the Prize is open to all members, Regular, Life, Honorary and Associate, and to all persons entitled to become members, provided such membership be completed before the submission of the Essay. Members whose dues are two years in arrears are not eligible to compete for the Prize until their dues are paid.

2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1886. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Judges.

3. The Judges to be three gentlemen of eminent professional attainments (to be selected by the Board of Control), who will be requested to designate the essay, if any, worthy of the Prize, and, also, those deserving honorable mention, in the order of their merit.

4. The successful essay to be published in the Proceedings of the Institute, and the essays of other competitors, receiving honorable mention, to be published also, at the discretion of the Board of Control; and no change shall be made in the text of any competitive essay, published in the Proceedings of the Institute, after it leaves the hands of the Judges.

5. Any essay not having received honorable mention, to be published only with the consent of the author.

6. The subject for the Prize Essay is, *What changes in organization and drill are necessary to sail and fight most effectively our war-ships of the latest type?*

7. The Essay is limited to forty-eight printed pages of the "Proceedings of the Institute."

8. The successful competitor will be made a Life Member of the Institute.

9. In the event of the Prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of a gold medal.

ROBERT W. ALLEN,
Secretary and Treasurer.

ANNAPOLIS, MD., *February* 13, 1885.